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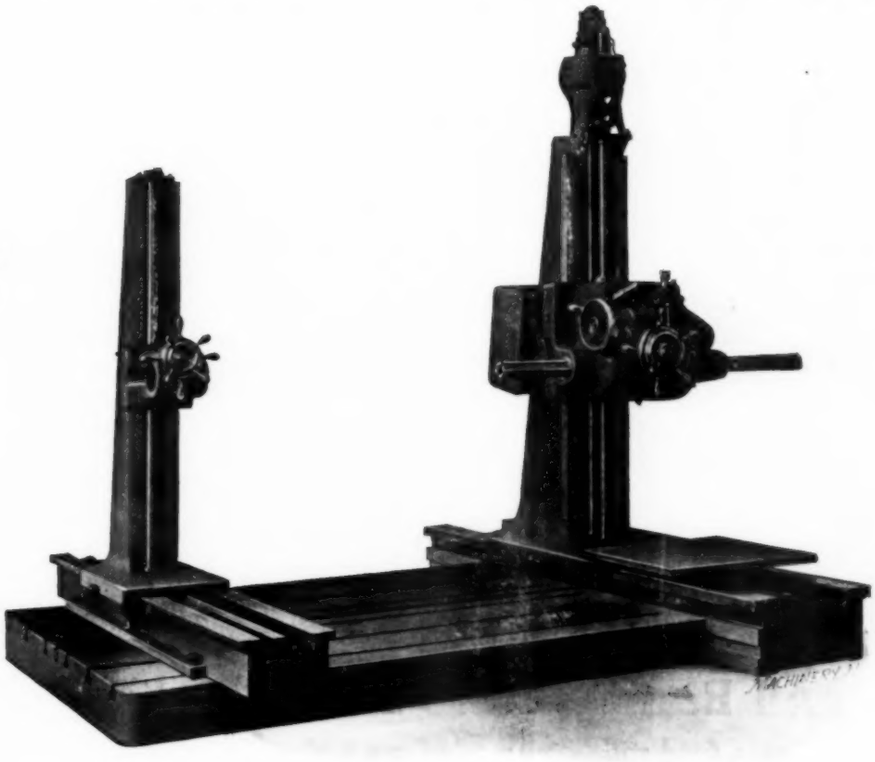
Rochester Horizontal Boring Drilling, Tapping And Milling Machine

See page 31 for further details



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Study this Cut Carefully—Notice the Centralized Control

With this machine every operation is controlled from one position convenient to the work—*that* is the conspicuous point of superiority in this tool. Combined with that is the *continuous* traverse of the spindle for *any length* and other modern improvements that make for more rapid and accurate work at lower cost. Let us show you why this heavy duty machine, with its array of exclusive features, is worth investigation.

Write for Special Bulletin giving complete description and specifications.

Rochester Boring Machine Co.,

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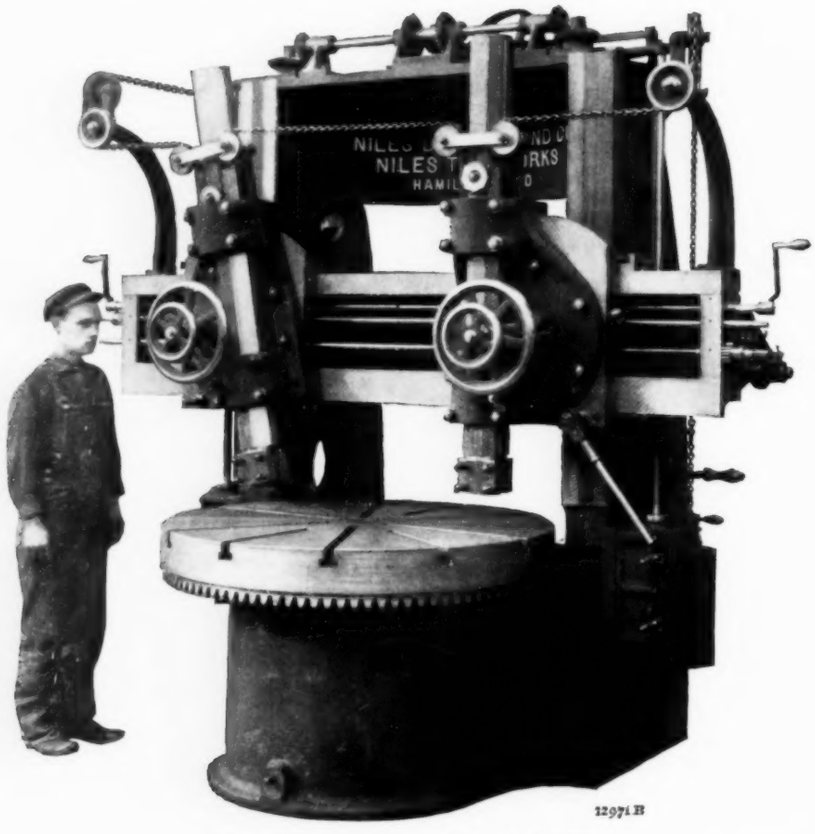
No Belts on the Motor Driven Machines



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No part of machine extends below floor

Bed, housings and top brace are cast in one piece on the smaller sizes, ensuring greatest rigidity, compactness, and perfect alignment in all parts.

Tool bars are octagonal and have four sides scraped to a bearing.

This is the strongest and most rigid form of section and allows bars to enter comparatively small holes for boring. The counterweight for each head is INDEPENDENT and placed out of the way in back of machine.

All Bearings Have Bronze Bushings

Screws, driving shafts, feed rods, etc., made from high-carbon forged steel. Gears made of best quality bronze, forged steel, steel castings, semi-steel or the best quality of gun iron.

Built in 25 sizes. Belt or motor drive.

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(*See pages* 51, 52, 53, 54, 55, 56, 57 *and* 58)

Jigs and Fixtures for Candy Machines

Editorial Correspondence

Jigs and fixtures for close drilling—others that are adjustable and universal.

An interesting scribing fixture and a lifting truck for handling work.

In the accompanying illustrations there are shown several ingenious jigs and fixtures used by the Confectioners Machinery and Manufacturing Company, of Springfield, Mass. Figs. 1 and 2 show a box-drilling jig for drilling numerous holes at various angles. In these illustrations the work is represented by *D*. *A* is a swinging leg at one end of the jig, which leg is reversible, so as to stand the jig in an angular position, first upon one side and then upon the other. A glance at Figs. 1 and 2 will show that the jig has been turned over in one of the positions shown and the leg reversed.

Referring to Fig. 1, the arrangement is such that a hole can be drilled through the bushing *G*. Examining Fig. 2, it will be found that this bushing *G* is there on the underside of the jig, and the hole at *B* is about to be drilled. This latter hole, as viewed in Fig. 1, was on the underside. In Fig. 2 there is also a larger drill placed in position through the bushing *C*. In Fig. 1 this bushing is on the underside of the jig and the drill has been removed. The drill standing in the bushing *C* is at a different angle from either of the holes *B* or *G*, and when drilling through *C* the leg *A* is swung up out of the way so that the jig lies down flat upon suitable planed pads, bringing the drill at *C* to an upright position. In Fig. 2 the knob *E* is on the end of a pin latch which locks the leg *A* in position, and when *A* is reversed this pin snaps into the depression at *F*, holding it in the reverse position, as shown in Fig. 1.

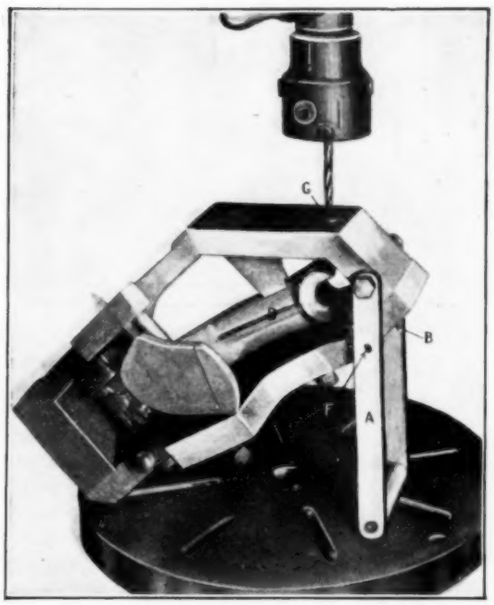

FIG. 1. JIG FOR DIAGONAL DRILLING

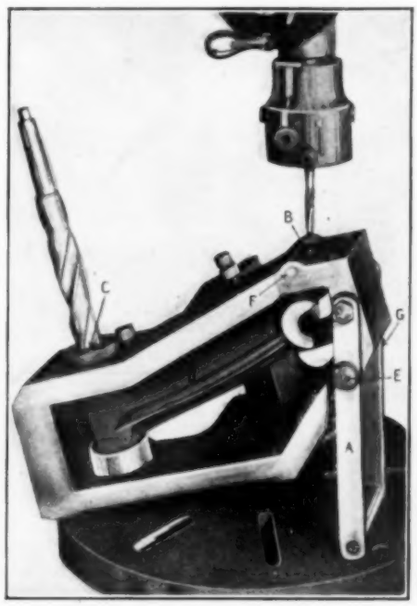

FIG. 2. JIG REVERSED. LARGE DRILL SHOWS ANGULARITY AND POSITION OF THIRD HOLE

CLOSE DRILLING

In the process of finishing one of the confectionery-making machines, it is necessary to drill and tap for grease cups on the bearing bosses of the main frame. This is shown in Fig. 3, where an electric drill *A*, through the universal joint *B* drives the drill *C* into the boss *D*. The casting *E* has a cylindrical projection, which extends through the bearing in the boss *D*, and by means of the wing nut *F*, the bracket carrying the drill universal joint, etc., is drawn down to the work, and so the drill is fed into the metal.

The spring arm *G*, passing through the loop on the handle of the motor *A*, keeps the latter from turning around and assists in making it rigid. The object of this arrangement is, of course, to drill close to the frame, which would be impossible otherwise, on account of the room taken up by the motor.

ADJUSTABLE JIGS

Several ingenious drilling jigs and fixtures are shown in Fig. 4. The long V-block *A*, with the sliding block *C*, is for drilling into a shaft *B*. Along the edge of *A* a scale is engraved, measuring from the pin *E*, against which the work is held. For the various shafts which have to be drilled, tables are furnished showing the locations at which the sliding block *C* must be put with reference to the scale on *A*, so that by drilling through the bushings at *D*, the holes are placed exactly where desired. In this way a number of shafts can be drilled exactly alike at one point, before moving the block for drilling them all alike at some other point, thus saving measurement, centering, etc. *F* is a clamp which is screwed down over *A* and *B* to hold the latter in place during the drilling operation.

H is an adjustable fixture for drilling wheel hubs on the diagonal, for set screws. The wheel hub is put over the boss *K*, which is located in the apron piece *J*, which latter is swung to various angular positions by the screw *L*, to bring the wheel hub to the correct angle when *H* is placed upon the drill-press table. *G* is simply a handy form of counterboring tool, the cutter being put through the arbor, which is hardened and ground on the bottom end to act as a pilot, and the lock nut screws down upon the cutter to hold it in place.

FIG. 3. FIXTURE FOR CLOSE DRILLING WITH ELECTRIC DRILL

UNIVERSAL DRILLING JIG

Fig. 5 shows some unusual drilling devices. *A* is the frame of a jig for drilling flat iron and may be used for a var-

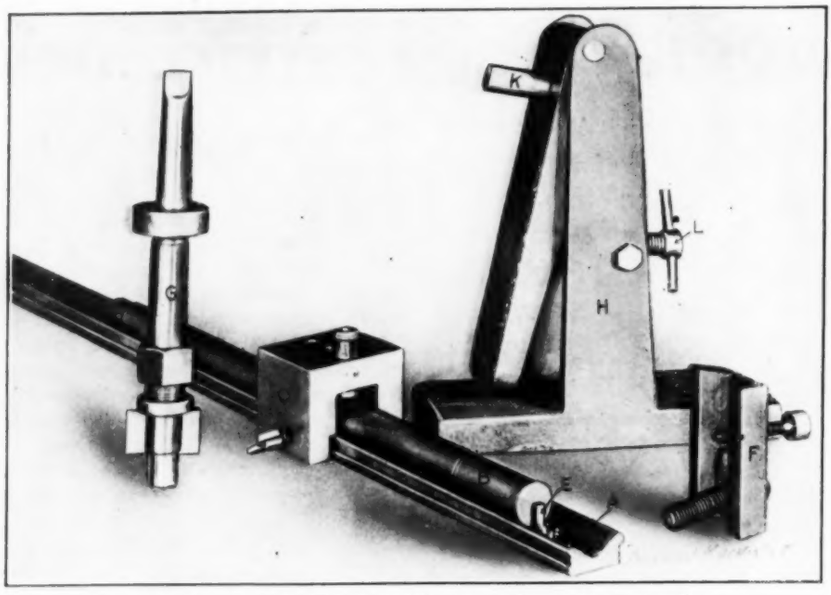

FIG. 4. ADJUSTABLE DRILLING JIGS AND COUNTERBORING TOOL

iety of hole locations. The pieces to be drilled are laid along *A*, between the upright posts, and the proper jig, having the drilling bushings located for that particular piece, is laid upon the top and held down by the several clamps on the posts. By examining the various jigs marked *B* in Fig. 5, it will be noted that not only are the drilling bushings in different locations on each, but also there are notches in the side, these being marked *C*. Now the posts in *A* are arranged at unequal distances, and the pieces *B* are notched at such points as to bring the bushings in the right position relative to the end pin, which locates the work. It is impossible to put any jig in the wrong place, as the locations of the posts and the notches are such that they will fit in only one position, and that the right side up and right end to. This also prevents ever using the wrong jig for any piece.

In Fig. 5, also, the letter *E* points to a device for countersinking under a ledge. The work is a casting *K*, and the countersinking tool is just under the edge at *G*. Owing to the shape of *K* it is impossible to either drill or countersink directly downward, so this method of working under the ledge has been devised. The spindle *E* drives the three gears *F* upon the spindle of the right-hand one of which is the countersinking cutter, on the underside. The thrust required to force the countersinking tool into the work is balanced by the spring *H* at the other end, thus preventing the spindle *E* from bending under the pressure. The whole apparatus is prevented from turning around by dropping the spindles down into the holes in the bed plate shown.

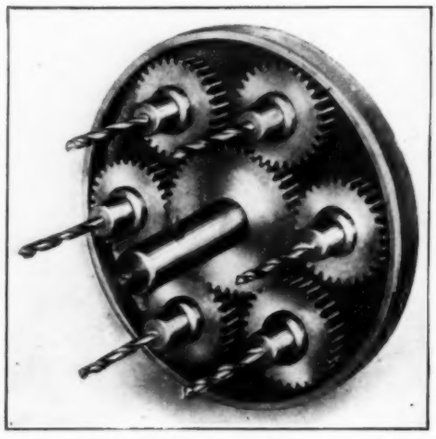

FIG. 6. BOTTOM VIEW

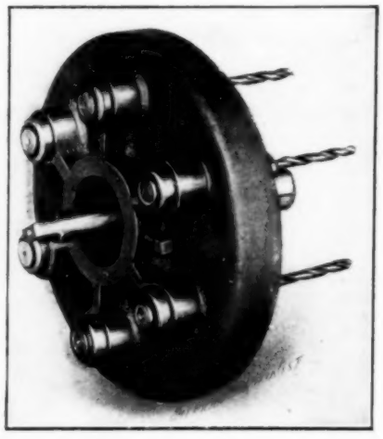

FIG. 7. TOP VIEW

MULTIPLE DRILLING HEAD FOR DRILL PRESS

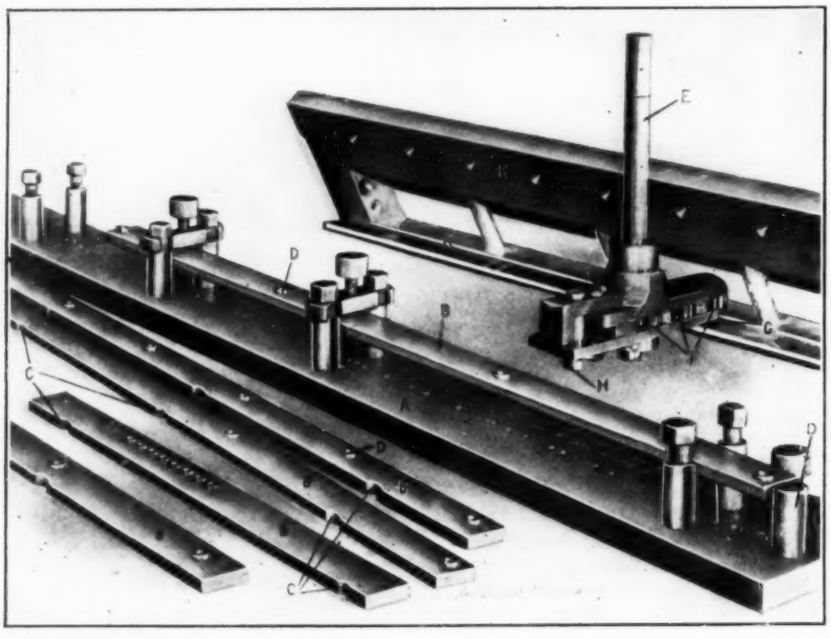

FIG. 5. DRILLING JIGS IN FOREGROUND. DEVICE FOR COUNTERSINKING UNDER A LEDGE, IN BACKGROUND

Multiple-spindle drilling heads are not unusual, but Figs. 6 and 7 show a neat form of such a device used in this same shop. Of course, the driving is done on the center spindle, which carries the gear for driving the six outside spindles and drills. The body of the head is supported on the drill-press frame, clamped by the set screw in the collar shown in Fig. 7.

SCRIBING FIXTURE

In one of the machines made by this concern, that is, a chocolate-coating machine, there is a paddle which is used to mix up the chocolate in a half-cylindrical trough of sheet metal, this trough slanting on its bottom cylindrical side. It used to be difficult to grind the paddles so that they would fit the trough with the 1/16-inch clearance which is necessary, and the device shown in Fig. 8 was conceived to overcome the difficulty.

In this fixture the paddle is mounted on a shaft carried by a yoke piece, and a line is scribed at *B* by the scriber ex-

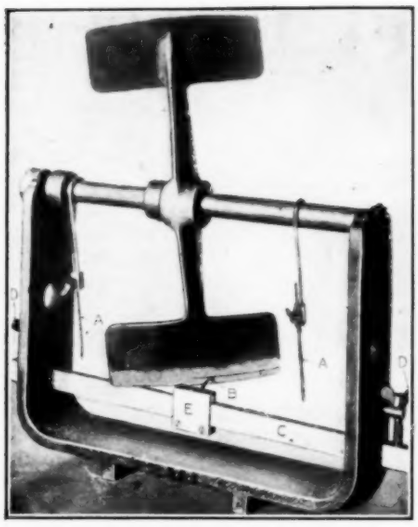

FIG. 8. DEVICE FOR SCRIBING PADDLE BLADES TO FIT MIXING TROUGH

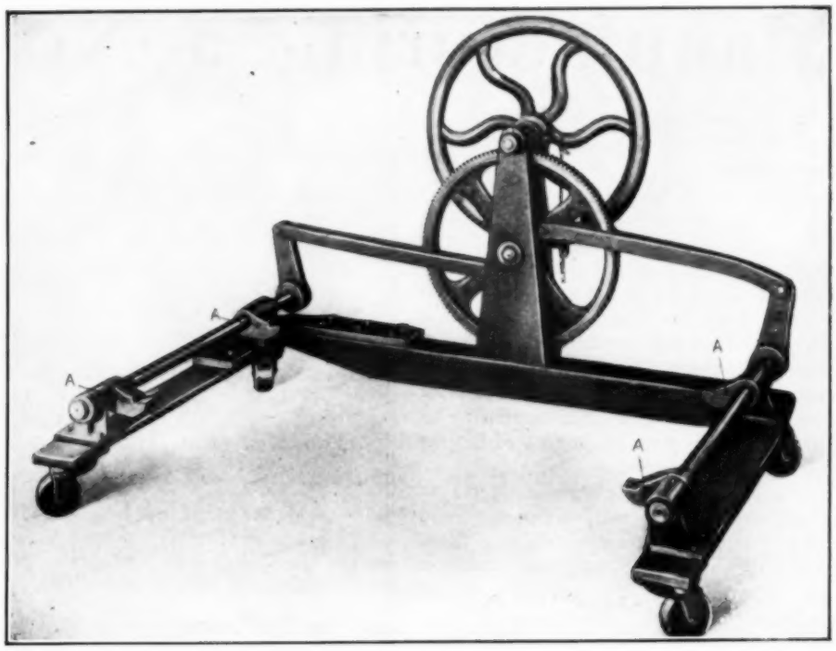

FIG. 9. PICKING-UP TRUCK FOR HEAVY MACHINE ASSEMBLIES

tending out from the sliding block *E*. In order to locate this line, the two gages *A* are hung in the trough of the machine under construction, and their length is adjusted by the thumb screws, so that as they hang upon the shaft their bottom ends just touch the slanting cylindrical metal trough. These gages are then brought out and hung upon the shaft of the fixture, as shown in the illustration, and the block *E* slid first to one side and then to the other, the rail *C* being adjusted vertically at each end by the wing nuts *D*, so that the point of the scriber on *E* is just 1/16 inch above the bottom end of each of the gages. In this way the proper slant is given to the bar *C*, so that the line drawn by the scriber will be parallel to, and 1/16 inch above the bottom of the slanting cylindrical trough. The paddle blade is then ground back to this line, and fits the trough without further manipulation.

LIFTING TRUCK

Some of the candy machines are quite heavy, weighing as much as a ton apiece, and it was found necessary to move these around the erecting floor at frequent intervals. The difficulty of picking them up and putting them on a truck was considerable and there were no overhead cranes, so that it became necessary to devise a truck; see Fig. 9. The frame of this truck is such that it straddles around three sides of the machine to be lifted, and by turning the handwheel, the four fingers *A* may be dropped down underneath the edge of the machine frame. Then by reversing the handwheel, these fingers come up and lift the whole machine clear from the floor, when it may be pushed around on the truck, which is mounted on casters, as shown.

S. B. R.

Records Which Lead to Promotion

The Collinwood shops of the Lake Shore Railroad have a plan for keeping a record of the characteristics of the men which is not found in many places. One of the cards used is shown in reduced form herewith.

The object is to have a record of all the men so that their various characteristics can be noted when new foremen are wanted or for any other reason.

These cards are filled out by the foreman of each department and they form a check on any personal animosities that might arise after a term of service. These cards are kept in the office so that the foreman cannot copy the old cards when making out new ones, as must be done every three months. This makes it as much of a test of foremen as of men, for it shows their ability to study men and judge of their capacity.

Assuming that a foreman formed a dislike for a man, he could not suddenly give him a low rating on these cards because the previous cards are always in evidence to compare with. As a matter of fact this is not its most important use, but is only mentioned to show one of its workings.

A small shop would have little need of it and few large shops would, we fear, carry it out faithfully enough to make it of great value. It shows, however, the qualifications which are considered desirable when men are to be promoted to better positions.

NAME

EMPLOYED AT

AS

	Very Good	Good	Medium	Poor
EDUCATION				
SPECIAL KNOWLEDGE				
EXPERIENCE				
HONESTY				
MORALITY				
TEMPERANCE				
TACT				
RESOURCE				
RELIANCE				
FORESIGHT				
APPEARANCE				
MEMORY				
ENERGY				
INITIATIVE				
PERSISTENCE				
ASSERTIVENESS				
DISCIPLINE				
PROMPTNESS				
ACCURACY				
SYSTEM				
ORGANIZATION				
EXECUTIVE ABILITY				

MADE BY

DATE

While bronze cannot be hardened by quenching or the addition of carbon, similar to iron or steel, it is pointed out by the *Brass World* that bronze can be case-hardened in a manner making it more valuable for certain lines of work. The method described is to coat the surface of the die with pure tin, and then heat the die to a low red heat in order to alloy the tin with the bronze metal on the surface.

Manufacturing a Novel Jar Cap

By Frank A. Stanley

This cap is composed of a metal outer ring and an inner shell, a cork disk and waxed paper lining. The metal parts are blanked, drawn up, nurled and notched, and the whole cap assembled in a series of interesting press operations.

An account of the press equipment, with details of the feeding apparatus, tools and method of advancing the work from start to finish.

In the accompanying illustrations are tools devised by the V. & O. Press Company, Glendale, L. I., for manufacturing a special form of bottle or jar cap in which a nurled cover is rotated slightly by the hand to close the mouth of the receptacle tightly. This closing action is brought about by five cam slots in the periphery of the cap, which act upon a series of lugs embossed upon the internal member, a slight rotary movement of the exterior cap thus causing the interior member with its cork-lined bottom to be drawn securely over the mouth of the jar or bottle.

The cap is shown clearly in Fig. 1 as it appears when assembled complete and ready for use; this engraving also illustrates the outer ring, the interior member and the cork disk which is seated in the bottom of the inner member, when assembled in place.

Making the Inner Cover

A number of operations are required to produce the two metal parts and the sequence in the production of the inner member is illustrated in Fig. 2.

The first operation on this piece is performed in the inclined V. & O. press shown in Fig. 3, where the sheet-steel strip is carried from the reel by a roll feed to the combination die which blanks the work and forms the shallow depression shown at *A*, Fig. 2. From this press the blanks are taken to a dial-feed press carrying two sets of punches and dies and at the first stroke of the press the indentations in the lugs are embossed as shown at *B*, Fig. 2, while the second stroke folds up these lugs and the entire rim of the piece into the cup-shaped article seen at *C*, Fig. 2, this completing the inner member ready for assembling.

Operations on the Outer Shell

The series of operations on the outer shell or cap proper is indicated in Fig. 4. In an inclined press similar to that shown in Fig. 3, the piece is blanked and drawn in a combination die to the shape shown at *D*, Fig. 4. This leaves it in the form of a shallow cup having two diameters. The work is then taken to another press, where it is fed by a dial under the different punches.

In this machine the work in the form seen at *D*, Fig. 4, is first carried into position for the nurling of the edge which is accomplished by a punch having a series of fine teeth upon its periphery which forces the piece down into a die corrugated to correspond with the teeth on the punch, this producing the effect shown at *E*, Fig. 4. At the next stroke the open edge is curled inward as at *F*, Fig. 4, and the third stroke cuts the bottom out of the piece leaving the work in the form of a ring as at *G*. The final operation in this press is to punch the five cam slots in the periphery, as shown

Fig. 1. The Assembled Cap and the Part

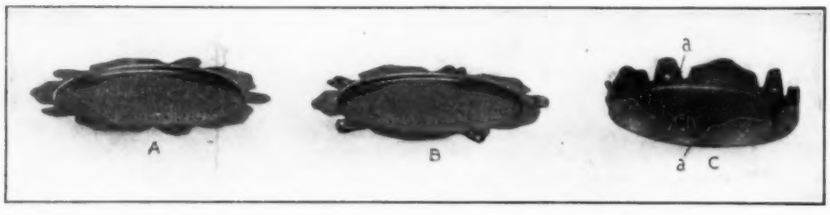

Fig. 2. Internal Shell for Cap in Different Stages

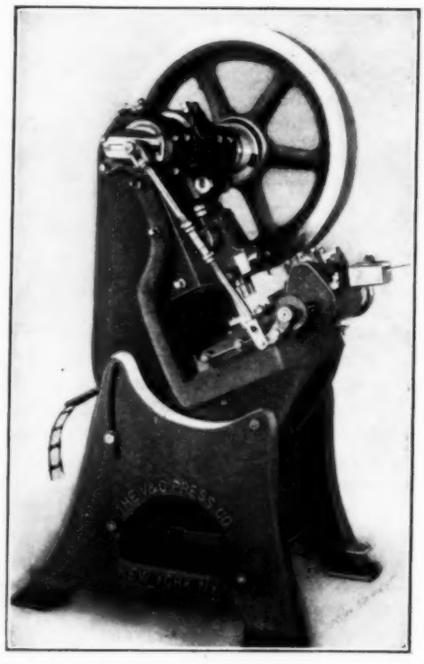

Fig. 3. V. & O. Press Operating on Jar Caps

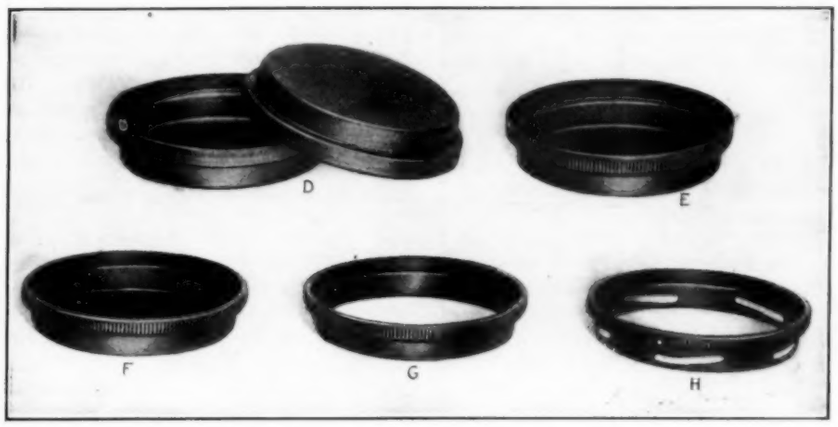

FIG. 4. SEQUENCE OF OPERATIONS ON THE CAP

at *H*, an operation which is accomplished by a series of radially moving punches which are forced against the ring on the down stroke of the ram by an under motion and positively released by the same mechanism, the finished ring being carried upward into the dial by a compression spring. The dial then moves the ring to the next position and it is then ejected downward by a plunger. The outer and inner parts of the cap are now nickel-plated and are ready for assembling.

METHOD OF ASSEMBLING IN THE PRESS

The press illustrated in Fig. 5 accomplishes the important work of assembling the parts of the cap.

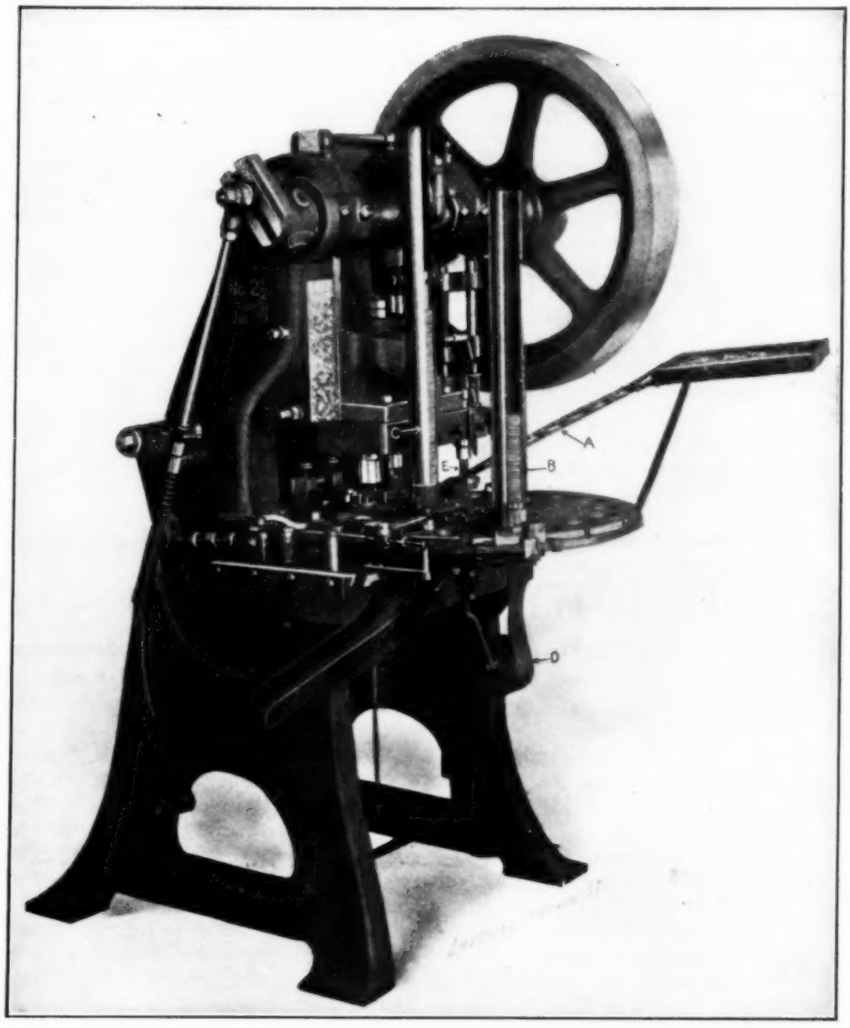

FIG. 5. PRESS AND TOOLS FOR ASSEMBLING THE CAP

In this machine the internal member is fed down an inclined chute *A* at the right-hand side of the machine, while the outer rings are automatically fed down the vertical tube *B*. The other tube *C* also placed vertically, carries the cork inserts. A strip of waxed paper from which disks are cut and pressed into place before the cork is inserted, in order to prevent moisture reaching the metal at the bottom of the cap, is carried on a reel *D* at the center of the machine. The

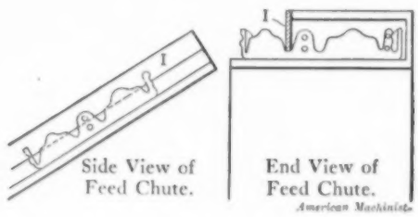

FIG. 6. INCLINED FEED CHUTE WITH GUIDE ROD FOR THE WORK

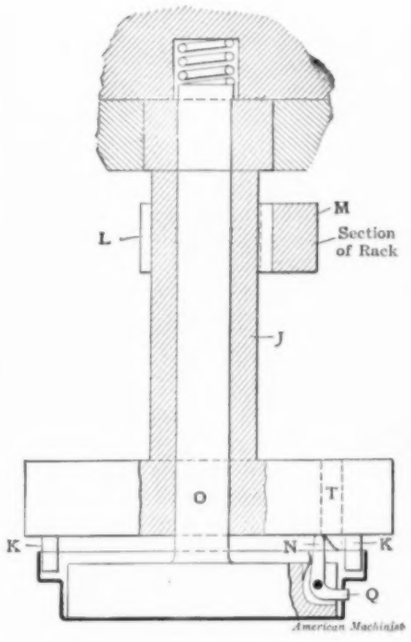

FIG. 7. DEVICE FOR LOCATING CAP IN CORRECT POSITION FOR RECEPTION OF INNER SHELL

paper is passed through a blanking die by a roll feed attached to the rear of the bed of the press.

In operation the nurled outer rings are dropped one by one into the feed dial as it indexes around under the feed tube and between the press tools, and upon arriving at the mouth of the inclined chute *A* at the right are ready for the reception of the interior members. As the latter have five lugs with projections embossed thereon to enter the corres-

ponding cam slots in the outer caps, it is obvious that the two parts must be placed in a certain definite relation to one another before they can be assembled. This means that each of the internal pieces must be fed down the chute in a certain way in respect to its lugs and the outer rim must be rotated against a fixed stop to locate the work from the end of one of its cam slots.

Registering the Work

The inclined chute has over the channel a guide bar arranged as indicated at *I* in Fig. 6, which permits the work to be slid into the chute in a certain position and in no other. The guide bar is slightly off center corresponding to the position of notches *a a*, Fig. 2, and the work can be slid down the chute with any of the five pairs of these notches engaging with the guide rod, but it is impossible to enter work with the notches at the other side of the lugs against the side.

For locating the outer shell, a device shown at *E*, Fig. 5, and also in the sketch, Fig. 7, is attached to the punch holder. It consists of a plunger *J* carried at the right-hand side of the ram and having equally spaced about its flanged head five knife-edged pins *K* adapted to engage with the inner surface of the walls of the rings. Near the upper end of *J* is a pinion *L* operated by a rack *M*, the latter being moved longitudinally by a link actuated by the stroke of the ram. The device thus serves to grasp the outer ring and rotate it in its seat in the feed dial. The work must be stopped, however, in a definite position relative to the cam slot in its periphery, and this is accomplished by the small stop *N*, which is pivoted in the spring-actuated plunger *O*.

How the Plunger Works

This plunger can slide vertically against the spring in holder *J*, but cannot rotate, being fixed to a clamp ring at the top which prevents it from turning. Now, as *J* descends carrying plunger *O* into the work, teeth *K* engage the ring and rotate it about *O* until the wedge or dog *T* strikes the upper end of stop *N* swinging it into one of the cam slots in the side of the work and stopping the latter when pins *K* have turned it sufficiently to bring the end of the slot against the lower end *Q* of the stop. Upon the upstroke of the ram, plunger *J* with its knife-edge pins *K* is lifted from the work and clears dog *T* from the stop *N*, allowing the latter to spring in and release the ring at the same time clearing it sufficiently to prevent its being lifted from the hole in the feed dial when the plunger *O* ascends.

The outer ring is now properly located to receive the inner member and upon the next advance of the dial one of the inner steel drops into place and the second punch in the ram presses it down into position, with the lower set of indentations around its lugs sprung into the cam shape slot in the outer ring. The inner projections of these lugs engage the top of the bottle or jar to which the cap is attached.

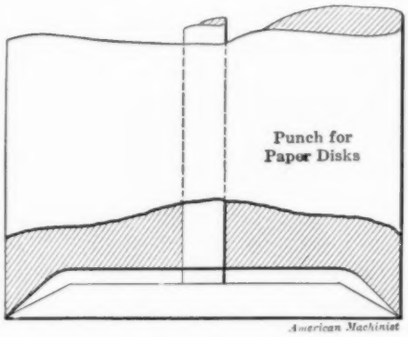

Fig. 8. Punch and Ejector for Waxed Paper Disk Used in Bottle Cap

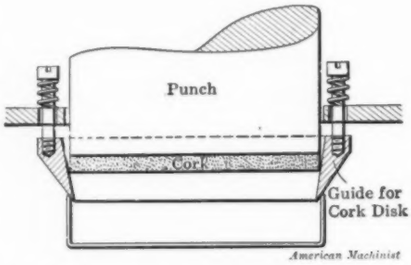

Fig. 9. Guide for Carrying Cork Disk into Its Seat in Bottle Cap

Inserting the Paper or Cork Disks

At the next advance of the dial a disk is cut from the slip of waxed paper and pressed into the inner member of the cap by the ejector shown in Fig. 8. This is merely a thin disk with a bevel edge and a shank which fits into the punch. It operates by gravity and although it falls before the punch strikes the paper, its weight is not sufficient for it to cut the latter. However, as the paper disk is cut out by the keen-edged punch, the weight of the ejector carries it down into position at the bottom of the cap.

In the next position the cap is provided with a cork disk, which is fed out of the bottom of the tube shown at *C*, Fig. 5, and which is carried by its punch down through a tapered die ring into the cap. The arrangement of this ring is shown in Fig. 9. The ring is supported by springs as indicated. It has a knife edge, is beveled externally and tapered internally, so that it will enter the mouth of the steel cap which is to receive the cork insert, and, owing to the internal taper, causes the cork to be compressed somewhat so that it will be guided down into the bottom of the cap and clear the indentations in the lugs on its way down. The edge of the cork in going down through the guide ring puts sufficient pressure upon the latter to force it down against the action of its light holding springs and on the upstroke of the ram the springs lift the guide ring to its normal position. This completes the assembling of the cap.

The press has the same safety arrangement for feeding and controlling the mechanism as illustrated in the article by W. J. Kaup, at page 1086, Volume 32, Part 2.

Taking off Dimensions

Some concerns have the habit of making drawings of nearly every machine, of other makes than their own, which passes through their hands. For instance, were they to furnish one of Jones' milling machines or a couple of Playfair's brick presses when filling an order of machinery for the equipment of a manufacturing plant, they would purchase the foreign machines, have them shipped to their factory, and then set a draftsman to making detailed working drawings of the machines in question.

Of the moral side of this matter the least said in favor of it the better, but the draftsman has no choice. He must copy the machines or take 23 for his number on the time clock. Frequently it is very convenient to have such drawings on file, but they were evidently made with a view of duplicating the machine in the factory if it should prove advisable to do so.

To take off the dimensions of a machine in this manner is quite a task, and the writer has formed the habit of using one or more sticks of wood for recording the lengths of various portions of the machine. In fact, it is very convenient to make one stick for the machine before it is taken to pieces. A case in point occurred very recently where it was required to work out a new mixer and use all the parts possible from some obsolete machines.

A stick was secured, about 1×¼ inch, planed smooth on four sides, and mounted temporarily upon a straight-edge so that a square could be used for recording distances upon the stick, the straight-edge being used to keep the square in accurate position. To use this device the straight-edge was clamped conveniently adjacent to the machine, a point of departure chosen, say the end of a convenient shaft, or some extreme portion of the machine and a line struck on the stick perpendicular (square) to this point.

Then the square was moved along to the next point which was to be dimensioned—say the end of a journal bearing. Here another line is squared upon the stick and plainly marked "end of solid bearing." Then the square is pushed along to the other end of the bearing and another mark made on the stick, which mark is tagged "end of solid bearing" in a similar manner. The marking is proceeded with, in similar manner, along the entire length of the stick, all the points which can be possibly needed in making the drawings, are thus squared over upon the stick and appropriately tagged with some name or description which cannot be mistaken for anything other than what it is intended. And right here, look out, for it is easy to become confused in the marking.

After the marks have all been made, remove the stick to a bench or some convenient board, and put on the dimensions of each and every mark, measured from the point of beginning the measurements. Run a short line from each dimension to the mark it is intended for, and if possible, place each set of figures on the side of the mark nearest the point of beginning the measurements. Thus there will be two lines of writing on the stick, one a description of what the mark belongs to, the other the distance of each mark from the end of the stick from which measurement was commenced.

When laying the machine down on paper, and it is desired to determine the distance between two parts of the machine, simply select the two marks upon the stick which represent the two points in question, then subtract one from the other, the distances of each from the point of beginning. The result will be the distance between the two points, and it may be relied upon as correct, provided the stick has been accurately laid out.

There is no chance of duplicating errors in the method here described. If an error be made in locating a mark, it will affect only two dimensions, one on either side of the faulty mark, whereas if the usual manner of taking measurements be followed, and dimensions taken from point to point, and added to total the entire length of the machine, then there is a chance for numerous errors to neutralize each other, total correctly, but to cause much trouble before they are run down and eliminated. In laying out shafting, this method leaves nothing to be desired. A stick is not needed, but on the drawing all the dimensions are to be taken from the end of the shaft and "local" dimensions obtained by subtraction.

Locating Buttons on Jigs

By H. Lamb

A method of locating buttons on jigs and similar tools applicable to accurate work.

Handy and rapid in actual practice.

It is some time since I came across the following method of locating buttons on jigs and similar tools, and as I, along with others, have used it on accurate work, such as tools for guns and gun parts, I believe it may be of interest to readers.

Take a piece of tool steel and mill it approximately to shape, as shown in Fig. 1. The size, of course, can be varied to suit the toolmaker and the job. *A A* are pins about 0.1 diameter made of drill rod and hardened at the end not in the block. The block is ground top and bottom.

Suppose we have to locate a button or number of buttons on a jig, Fig. 2, from the side *X* parallel to the surface plate angles to each other. Proceed in the usual manner to lay out roughly the position of the button, drilling and tapping a hole and securing the button with a screw somewhere near its correct position. Next clamp the job to an angle iron with the side *X* downward, as in the sketch. With the tool just mentioned, which we will call a "feeler block," set the side *X* parallel to the surface plate by first setting the feeler pin so one can just feel it pass under the side at one end, then rap the job up or down at either end until the pin touches with the same "feel" all the way along the side.

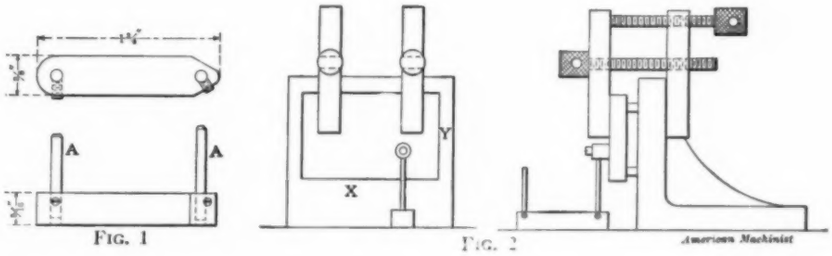

FIG. 1 FIG. 2

LOCATING BUTTONS ON JIGS

Measure the overall length from the under side of the feeler block to the top end of the pin, with a micrometer, and jot down the figures. Replace the pin with another one enough longer so that it will reach the required distance to the button, and set it with a micrometer to the correct length. Turn the angle iron on its edge and measure the distance to the side *Y* with a pin in the other end of the "feeler block." Again, after measuring the distance with a micrometer, replace this pin with a pin enough longer to reach the desired position of the button, setting again with a micrometer.

By first feeling from one side, then from the other, one can locate a button in less time than it takes to describe the process. Then the beauty of it is, the button is located as accurately as it is possible for one to measure with a micrometer and the time required is reduced to a minimum, for it does not take long for a tool maker to acquire a "touch" that will enable him to measure to a very fine degree of accuracy. This tool can be used not only for locating buttons, but in assembling parts of gages, fixtures, etc., and for measuring up finished tools.

In making the base of the tool, I make one end a different shape from the other, so I can tell at a glance which has the longest pin if the lengths should happen to be nearly alike, and I put the screw near the top edge so as to get the greatest amount of adjustment for the pin. By having the hole reamed out a good fit for the pin, and the screw just tight enough against it to hold, it does not take much of a rap to adjust the pin.

By having one such base and several pins on hand, a great range of measurements can be made, but after one has tried this method, it will not be long before he has several of these feeler blocks in his kit, of different sizes to suit different jobs.

Broader View of Industrial Education

By Dexter S. Kimball*

Industrial education will pay when it is suited to and is an expression of the life of the community. We are now in the midst of a storm of conflicting ideas and whims. The best results will undoubtedly be obtained from a carefully planned educational system under ***communal*** *control.*

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Serious defects in our social or political organization are often made manifest by the local remedies applied by the groups first affected. This is natural and necessary, as permanent reforms must grow, to a certain extent, out of our experience. The true relation of local remedies to each other and to the problem as a whole can, however, be appreciated only by a clear understanding of the underlying causes which have led to the need of these remedies. These conditions seem to apply to the industrial education movement. Many and diverse schemes to meet changed conditions are being advocated, the view point of each being directed by the needs of the community considered; and there seems to be some danger of a failure to recognize fully the underlying causes and also some general principles bearing thereon which are a part of the experience of the race.

The average degree of physical comfort and the mental enlightenment and culture resulting therefrom which any people can enjoy is governed, largely, by two factors, namely: the natural resources of the country which they inhabit, and their ability to develop and utilize these resources. Thus a nation inhabiting a very fertile region may have great difficulty in holding its own, commercially, against a people occupying a comparatively barren country but possessing superior intellect and more effective methods and tools of production. Predatory nations and the results of predation are not included in this analysis.

Principles of Production before the Eighteenth Century

When, by the dim light of history, we examine the great ancient civilizations that have preceded ours we find them, for the most part, occupying fertile territories. We find the *upper* classes of these old nations enjoying a degree of civilization and culture comparable with similar classes in our own day. But when we examine the tools of production with which the producing classes were equipped we are amazed at their primitiveness, and cannot but marvel at the results which these ancient workmen achieved. These results are the more remarkable when it is considered that these tools were wielded for the greater part by slaves or at least by workers very low in the scale of civilization. Even in later times, when European handicraft had reached its highest development and the tools of production were wielded by free men, we still find the actual producer occupying a low social plane, usually poorly fed and clothed, and almost totally uneducated. Brief reflection will convince anyone that these conditions must be necessarily so; and that in any form of organized civilization of which we have knowledge, and which is supported by handicraft and primitive methods of production, culture and enlightenment of the upper classes can be maintained only by the existence of a large and unenlightened producing class. And the more primitive the tools of the producing class the nearer must their condition approach that of slavery in order to maintain even a moderate average degree of intelligence in the nation.

Up to the middle of the eighteenth century every civilization of which we have knowledge based their political structure on the preceding principles, and many are still so supported. The skill of hand and simple "mysteries" of the craft were transmitted from the father to son, from craftsman to apprentice, and scientific processes in the modern sense were little known. The only organized method employed for increasing the output of the primitive tools in use was the old and well known principle of division of labor; and the full benefits of the principle were seldom attained.

Era Following the Industrial Revolution

With the industrial revolution in the latter part of the eighteenth century and the introduction of labor-saving machinery came a new era. The old handicraftsman who was both creative and constructive was, to a large extent, eliminated. By an extension of the principle of division of labor his functions were distributed among a number of men each of less general skill than the old craftsman possessed but equipped with tools especially fitted for the work to which each was detailed, far more efficient than the world has even seen. *Expert special knowledge* has become the essential requirement of the producer. The introduction of modern so called scientific principles and methods into the industrial field has hastened the change and made necessary new classes of more scientifically trained men in an ever increasing ratio. For almost each day sees some article formerly made by empirical handicraft methods transferred to the field of mass production with scientific processes, highly specialized machinery, and accompanying division of labor.

That these new methods are more effective than any that have ever preceded them is now established beyond question, and only those nations which have adopted them have made material progress. They are probably, but not necessarily, here to stay, though their management may be greatly modified. For while their effectiveness cannot be denied, their operation at highest efficiency is accompanied by certain defects, both social and commercial, which are deserving of gravest consideration.

A Pronounced Defect of the New System

One of the most pronounced defects of the new system is that it is not self perpetuating as far as the workers themselves are concerned. The old handicrafts were self sustaining in every way, the skill and knowledge being handed down from one generation to another. But modern methods when worked at highest efficiency afford little or no facilities for such transfer of knowledge and skill and the new industrial field must be fed with men whose acquirements vary all the way from the highly trained scientific specialist to the operative with little skill of hand and low intellectual development.

It is important to note that the nations where these methods were first introduced have been, as a rule, very slow to recognize and remedy the defects in the system, and more important to note the apparent reasons for this slowness. At the time of the industrial revolution, European philosophers and statesmen were much concerned with a form of speculative philosophy which affected very materially the political economy of that day. This philosophy was subjective, and individualistic and failed to recognize the fact that in a complex civilization many problems which were formerly individual in their character become communal under existing conditions. For instance in a complex political organization the State may, and perhaps must, to secure highest efficiency demand a better and more systematic training of the rising generation than can be given by the family or even by a small community. This principle has, of course, been more fully recognized in the older European countries, but in America today there is a strong movement in this direction and this must be kept in mind in considering national problems.

Germany the First Nation to Try and Remedy These Defects

Germany, though not the first to apply the new methods of production, has been the first to fully realize their import and

provide in some measure against the inherent defects of the system. This has been due, undoubtedly, in a large measure to the teachings of her philosophers and political leaders, and has not come about through efforts to remedy local difficulties. Germany, as a nation, has frankly recognized that man's progress both material and mental is governed to a large extent by his command over his surroundings, has recognized that many of his industrial needs are communal, and has reörganized her system of instruction accordingly. This educational system has not been organized to meet a few specific needs, but is national in its character and permeates the whole economic system. The industrial success of Germany needs no comment. In 25 years Germany, though a country of very limited natural resources, has raised her industry and commerce to a position which it at once the envy and fear of all countries which depend to any extent upon manufacture or trade.

America Has Been Slow to Take Action

America has been very slow to recognize the true import of these changed conditions mainly for the following reasons. First, we possess a country whose natural resources were apparently unlimited, so that with our abundant native talent we could live in luxury and took no thought for the morrow. Secondly, our methods of instruction have been based on the old individualistic ideas inherited from our ancestors and these took little or no cognizance of the necessity of controlling our material surroundings. The objective point of all instruction was the building up of character to the exclusion almost of power of production. Thirdly, we are a very self-satisfied nation and are very loath to concede our inferiority in any respect. Some of the most severe comments ever made on this attitude were those made by certain German visitors to the St. Louis Exposition, who assured the German people that they had nothing to fear from America so long as this complacent Americanism existed, and we were content to depend on our natural resources and native talent without systematic and special training for industrial workers.

Suddenly, however, it has been impressed upon us that we are rapidly becoming an old nation; that our resources are far from being inexhaustible, and that the new social problems arising out of the changed industrial conditions must be faced and solved. Our manufacturers are finding that they must apply the new methods with ever increasing efficiency, with the defects of the system becoming more apparent daily. In this dilemma, with the experience of Germany in mind, we have naturally turned to the reörganization of our educational system in hopes of obtaining a solution.

Will a Reorganization of Our Educational System Pay?

But there are many among us, including manufacturers and educators, who are not convinced that such a reorganization of our educational system is desirable and put forward the pertinent question: Will it pay? Judging by the success of Germany, there can be but one answer to this question. No one can study what these people have accomplished and fail to see that industrial education will pay *when it is suited to and is an expression of the life of the community*. Even in this country, where industrial education has been confined largely to the much criticized higher technical schools of engineering, agriculture, medicine, etc., unbiased thinkers arrive at the same conclusion wherever the school has satisfied the needs of the people and contributed to their useful knowledge. It would be difficult, I believe, to convince the people of many of our agricultural States that their agricultural colleges do not pay. In fact, the tremendous growth of the demand for industrial instruction, both in private and public schools, is the very best proof that it does pay when properly organized.

The Problem of Organization

It is this question of the proper organization of these schools that is the most perplexing, and it is here that we have the greatest divergence of opinion. It is generally conceded that the German, or any other foreign system, is not suited in its entirity to our needs. This is due, largely, to our widely different political structure and the very different temperament of our workers. As a consequence, we are now in the midst of a storm of conflicting views. One would have all State schools, another all private schools; one would modify the present school system, another would establish an entirely separate system of industrial schools; one would have all trades taught in the school, another would have all trades taught in the shop; while still another would have a part taught in each.

Undoubtedly there is much good in all of the schemes proposed, and parts of many of them will, no doubt, find a permanent place in the completed structure; and all discussion and experiment is extremely useful for only out of our experience can we develop a system that will be suited to our needs and which will be an expression of our national life. Furthermore, private enterprise often points the way to what is really a public duty. It may well be that specialized separate schools under private or semi-private control will be not only desirable, but necessary to develop certain phases of the problem. I believe, however, that industrial education can be put on the best and most economic basis only through communal control, either municipal or State, even though this should eliminate some useful private enterprises.

It must be remembered that the problem is not one of training men for a few specific trades or of patching up a few defects in our industrial system, but it is one of creating a national outlook toward industry. The effectiveness of the German system lies not so much in its inherent superiority as in the fact that it is a *national system* and has oriented the view point of the entire nation as far as industry is concerned. The problem of organized productive methods in all its branches has long been carefully studied by Germany's ablest leaders; whereas in America little or no thought has been bestowed upon them except by those most directly interested. Industrial education, in a broad sense, is as much needed for our leaders, educators and legislators as for the humblest tradesmen.

Individual and Social Well Being Can Only Come Through Material Well Being

For there are in our midst thousands of men in all walks of life, who, through no fault of their own, have failed, absolutely, to grasp the wonderful possibilities of modern productive methods and their humanizing influences if properly governed and directed. Many of these do not even appreciate that good citizenship can come only through material well being; and profess to see in our rapidly increasing industrial interests a grave menace to the finer things of life. Not appreciating that industry is the life of any nation, and art the blossom of industry; not recognizing that by modern methods of production alone can the refining influences of art and literature be impressed upon the entire nation, they would kill the goose that lays the golden egg, by a return to primitive hand methods of production. For these, and for all men, the new system of education must provide adequate instruction in the philosophy of production and distribution, if we are to have industrial peace, stable conditions, and just legislation.

We Must Organize Distribution as Well as Production

Further it must be remembered that our new educational system, whatever it be, must take into account not only the production of wealth, but its distribution. Important as are the industrial difficulties of our modern methods, they are insignificant as compared with the social problems involved; and these will no longer await a solution. If we were operating our mills and factories with slaves, the problem would be much simplified and the social problems would practically disappear. But we are committed, in America, to self government by free men, and at the same time modern productive processes have surrounded us by a most

complex civilization involving most difficult problems which we propose to settle with the ballot.

The greatest defect in our industrial economy today is not lack of productive power, but lack of ability to distribute fairly and intelligently. In our haste to develop the tools of production, we have paid little attention to the science of distribution. And yet, practically all the schemes of industrial education proposed today premeditate only the increase of productive power on the part of the workman and propose to leave to the demagogue and political agitator the task of instructing the worker how to dispose of the fruit of his toil; thus putting him in danger of losing tomorrow what he makes today, by foolish legislation or something worse. Our new industrial education must, therefore, contain something more than instruction in skill of hand or mechanical intelligence. It must contain instruction in those subjects in which are bound up the experience of the race. Just as the education of those not closely connected with productive industries must contain instruction in the true relation which these industries bear to our national life, so must the education of the industrial worker contain those elements of the humanities which will make him an intelligent voter. It does not seem possible that these results can be obtained in their best form except by a carefully planned educational system under communal control of some kind.

Educating a Nation Industrially Should Elevate, Not Destroy Its Ideals

It has been objected that educating a nation industrially destroys its ideals, and those making that charge point to Germany as an example of a nation which has lowered its ideals by such a means. Undoubtedly the slavish worship of material things, for their sake alone, will lead to a degradation of ideals in either the individual or the nation; and if the American nation has material progress only in mind it is doubtful if anything will be gained by industrial education. If, however, the benefits arising from increased productive power be properly distributed, the result will be an uplifting of the ideals of the nation physically, mentally, and morally, to a higher plane than has yet been the privilege of any race to attain. In true industrial education lies the hope of humanity. Our philosophy, our religion and our politics are made up to a large extent of fragments from the great civilizations that have gone before, and there is little that is new in them. We cannot point to a single civilization among those that have preceded us that was not founded and supported on poverty, ignorance, superstition and their attendant evils. The power to produce in unlimited quantities, to feed, clothe and educate the multitude, is the one great new thing in our civilization, and anyone who has an intimate knowledge of modern productive processes knows that *compulsory* poverty is even now no longer necessary. If the people of the United States can be awakened to a full realization of the possibilities of their vast natural resources and abundant native talent under systematic development, there is no nation that can stand before us commercially.

If, however, we cannot solve the social problems which even now exist, and which will be accentuated by increased productive power alone, we can have no assurance that the republic will not go the way of all preceding nations; but if we can conquer them, and I believe we can, there will arise on this continent a civilization fairer than the mind of man has yet conceived, where there will be enough for all and where every man will receive his just reward.

An Accurate Depth Gage

By W. S. Rowell

The need of a depth gage for very close measurements and of a design that could be easily made in a poorly equipped tool room led to the design here described.

Almost all shop measurements are taken between two surfaces in a way parallel and facing in opposite directions. When we encounter a case of measuring between two surfaces facing in the same direction, special appliances are needed. Depth gages are such appliances designed to supply one surface facing opposite to one of the pair whose distance apart is being measured, thus establishing the usual conditions, a pair of surfaces facing in opposite directions.

A small inside micrometer, one of small diameter head, using rods of no standard length, was used as shown in Fig. 1. Fig. 2 might be a better design for some reasons. A plain set-screw clamp could be used in the place of the split chuck shown in Fig. 2.

In this form of gage the distance from *A* to *B* is fixed and known and may be checked for accuracy in a fraction of a minute by measuring with an outside micrometer. In using this gage, insert a needle of approximately the correct length, get the desired "feel" at the point of the needle while the gage is in position, clamp the needle and measure with an outside micrometer or measuring machine the distance from the point of the needle to *B*, subtract from this the constant *A B;* the remainder is the required size.

This gage never loses its accuracy by wear; the point of the needle may be altered without effect on its reading or its accuracy; anything that can be held in its chuck or clamp will serve as a needle. It can be made at comparatively little cost, and is both accurate and durable.

This depth gage permits measurements to be taken between two surfaces facing in opposite directions, the easy and natural way.

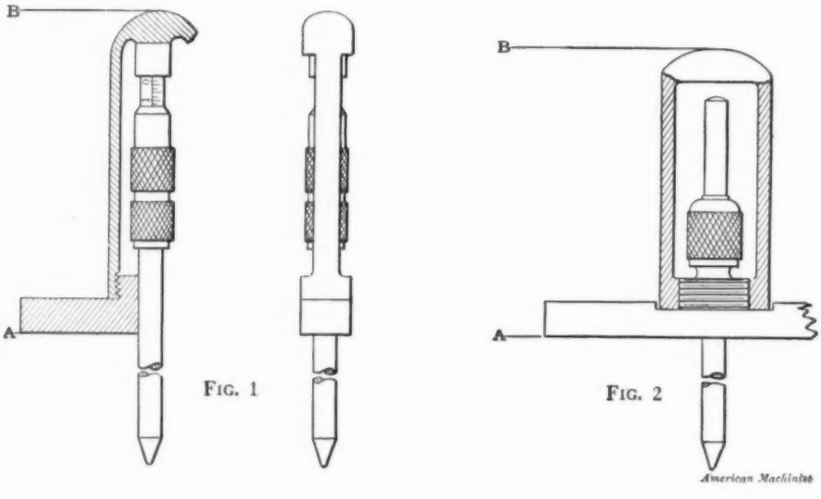


Fig. 1 Fig. 2

An Accurate Depth Gage

Aeroplane Constructional Details

By Warren H. Miller

Different materials used for framework. While bamboo is light and strong, its natural joints interfere with construction, so that light bicycle steel, hickory and ash are the most used. Wood is considered by many to be better than steel for compression members on account of buckling. Tension members are of steel wire, kept taut by turnbuckles or U-bolts. Wing surfaces are usually of rubberized linen.

Some machines are made with folding wings for convenient packing. There is some diversity in location of stability planes and their control, it being necessary to reduce the number of control levers to as few as possible.

The simplest possible conception of an aëroplane comprises two planes, one to carry the load and the other to control the load-plane; an extra light motor with screw propeller; and means for utilizing the pressure of the air to preserve longitudinal and lateral equilibrium. This conception involves at once a variety of structural considerations. The pilot of the machine must have facilities to manage the five controls of wings, motor and direction, suggested by the primitive conception; there must be suitable structural dispositions of the materials to take the stresses of the forces of the air, in carrying and directing the apparatus.

In aëroplane design the main scientific considerations have been thoroughly worked out for us by those who have gone before in the field—those scientists who themselves were doomed to see failure of actual flight greet each attempt—in spite of the time, money and thought that they put into the work. It is easy, now, to look back on their work and see what they lacked in available mechanical facilities to make their work a practical success. One might say that, in general, the motor of their day was the principal deterrent of success. We know now that the presence of human control, and that of trained expertness in the art of flight is absolutely essential for any continued performance of anything flying through the air. The most ingenious automatic appliances such as were studied out for Langley's machine on the Potomac, fall far short of the actual sentient control needful, but the motor of his day could not permit the extra weight of a man on the apparatus.

Today we have, thus far, put into successful use aëroplanes varying from the tiny one-man machine, such as the *Demoiselle II* of Santos-Dumont, to the large three-passenger flyers of Farman and Voisin, all, however, having the man, or pilot, as the essential director of the apparatus. In the former machine, Santos-Dumont has demonstrated that one can put together 220 pounds of motor wing area and control-vanes, to carry 150 pounds of man; a sort of aërial bicycle, so to speak, with which one can fly at will across country at a speed of sixty miles an hour, and have this ready to hand for daily service, just as one owns an automobile or motorcycle. When we realize that the *Bleriot XI*, only a little larger than the *Demoiselle*, is now in its 250th machine, built for enthusiastic French sportsmen, and that the *Demoiselle* itself is a standard commercial machine, manufactured by one of the best automobile companies in France, we can see the inevitable future of this type of machine. With the biplanes and with the multiplanes which will follow on their heels, the industrial, passenger aëroplane for heavy duty and slow speed is as sure to develop as was the dynamo thirty years ago. The ways in which our present structural problems have been met by the French constructors are detailed as follows:

Wings

In all the Bleriots, the wing frame is made of glued-up shapes of thin mahogany and hickory, this construction giving more strength and rigidity than bent natural wood, and permitting the frame members to be gotten out in almost any desired shape. Bleriot has adopted this construction after trying almost every known material suitable for construction of light frames. Bamboo, being very strong in proportion to its weight, is a material often used by experimenters, but is difficult to use in aëroplane manufacture because really straight pieces are not at all common, and the natural joints interfere materially with exigencies of construction. It may do for a few experimental machines, but for stock manufacture, running into the hundreds of aëroplanes, as Bleriot has done in the last year or so, it is hardly practicable. The use of light bicycle-steel frames for both wings and body was also rejected by this company, for the reason that the shocks attendant on practical aëroplane service are so frequent that a steel frame soon gets buckled out of shape. And, moreover, repairs are far more expensive and difficult with this material than with wood.

Both sides of the wing frames are covered with fabric, usually rubberized linen, as linen is cheaper than cotton in France. That manufactured by the Michelin Tire Company, has a resistance of 287 pounds per square foot, weighs 0.478 ounce per square foot, and sells at $1.20 a square yard. The same in cotton has a resistance of 236 pounds, weighs 0.458 ounce and sells at the same price. Japanese silk has a resistance of 143 pounds, weighs 0.262 ounce and parchmentized paper has a resistance of 164 pounds and weighs 0.524 ounce per square foot. In most of the French aëroplane constructions, rubberized linen has been adopted, because of immunity from stretching and other weather considerations.

In the Antoinette machines the wing frame is entirely of bicycle steel, covered on both sides with rubberized linen fabric. The frame complete, covered with the fabric, weighs 0.22 pound per square foot. In the *Demoiselle II*, of Santos Dumont, a single surface of fabric is used, fastened to a light, ash frame of bent strips of natural wood. These in turn are gained into two main wing members of hickory, steam-bent so as to form a wide open "V." In the Bleriots and Antoinettes, the position of the wings is secured by stout truss-wires, forming with the frame of the wings, a double truss with tensions resisting distortion, either upward or downward.

In either case the compression stresses coming down the frame are enormous, and so they must be provided for in the construction of the frame itself, and also in the body framework to receive these stresses. For this reason, also, any designs which have been worked out to turn the wings bodily about a horizontal axis to get a warping effect, are more or less being supplanted by placing the control of lateral stability elsewhere. The earlier Antoinettes had small vanes at the rear outer corners of the big wings, but their control was found to be a nuisance at such a distance, and they are now transplanted to the horizontal feathering in the tail. In the Bleriots, provision is made for warping the main wings bodily, but in the latest designs the upper tension wires are attached at four separate places on the upper wing surface, making any horizontal turning an impossibility, but the rear wires are movable over a pulley on the truss, thus warping the extremities of the wings with a helical form.

For practical aviation it has been found a great convenience to have the main wings capable of being dismounted and folded into the sides. This is effected by providing the wings with two lugs which can be keyed to the frame of the body, and putting hooks and turnbuckles on the tension wires. To dismount, simply loosen the turnbuckles and drive the keys out of the wing-lugs, when they can be taken off and folded at the sides. The plane can then be run along the road on its wheels, hitched up to a horse, or shipped in a box car.

In the *Demoiselle II*, the main hickory wing members have only the tension wires above. The supporting forces of the air are taken up from below, partly by the cantilever action of the main members and partly by struts which extend out from the lower part of the body frame and attach to the wings at about one-half their length from the body. As the wings are flexible, the lateral stability is obtained by simply attaching wires to the extreme tips of the rear main frame members. By pulling on this wire with suitable mechanism the wing is warped.

Among the biplanes, all the fabric surfaces are single and all of rubberized linen. In all of them the concavity of the surface is obtained by light bent strips of wood, but construction differs as to the main frames. In the Farmans and Voisins, this also is made in ash or walnut, with piano-wire tensions. In the later constructions of Sommer and Clément-Bayard, the uprights are of bicycle steel. In the Clément-Bayard a rim of hollow steel is run entirely around the edge of the portative surfaces, giving a very neat, strong construction. Curiously enough, these last two are the lightest of the biplanes, the Sommer weighing but 670 pounds for 388 square feet of portative surface, and the Clément-Bayard, 645 square feet for about 1100 pounds weight. In two of them the lateral stability is assured by vertical planes and cellular construction, and, of the other two, the Sommer has small vanes attached to the rear outer corners of the upper plane, and the Clément-Bayard has them entirely detached from the planes, mounted on separate trunnions in between the two planes, where they are quite as effective as if attached to the planes.

The Frame Body

Having designed the main portative surfaces, there must be a light frame to connect them with the governing planes, and with the motor which furnishes the driving power. In the Bleriots, following the same reasons for adopting wood for the wing frames, this is made entirely in natural ash as far as the compression members are concerned. Of course, one could form a wooden frame entirely out of combinations of triangles, in which all the members would be necessarily in wood. But this has turned out in practice to be open to grave difficulties in the warping and weathering of the members, so that the truss itself soon loses strength and form, and sometimes all the strains are concentrated on a few members. Further, there is no way to provide for shrinkage strains.

Still another consideration is that of rapidly taking the frame apart for packing and repairs, so that the frames of the present commercial Bleriots are all jointed rectangles having wood compression members and piano-wire tensions. The frame is of ash, weighs 45 pounds and will carry a load of 660 pounds con-

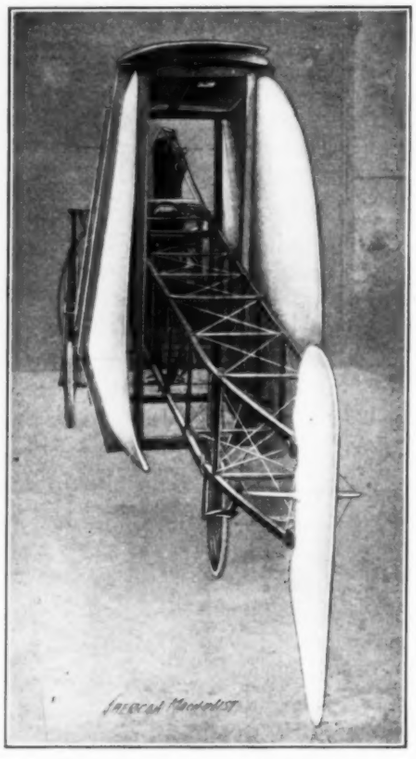


Fig. 1. Frame of Bleriot XI

centrated at the middle, when supported at both ends. There are four ash longitudinal members divided into eight sections by rectangular frames, which form the struts of the truss. All diagonals are wire, and tension is put on them by two modes: First, by a special turnbuckle with a lock-wire; and second, by U-bolts passing through the frame, the feet of the struts being slotted so that they can be taken up. Each U-bolt takes the loops of two tensions, which are first drawn as tight as possible by hand. Then the nuts of the U-bolts are screwed up and an initial tension thus put on the wires. If turnbuckles are used they must be locked in some fashion, as they soon unscrew and upset all the equilibrium of the joints. They must not be secured with locknuts, as this introduces an unknown initial set in the section of the wire, and one cannot depend upon what may be left of strength in the section at that point. Where U-bolts are used there are no metal foot pieces on the struts, but with turnbuckles these are put on and the eyes for securing the buckles cast in them. These pieces are cast in aluminum.

The front frame is expanded to include the frame of the landing chassis and two light steel channel sections, bored out in the web to give them less weight, are secured to it to form a frame for the motor. As in all the monoplanes, the screw revolves in front of the aviator and pulls the plane after it, so virtually the whole service of the body is to support the rear governing plane with its vanes and rudder. The pilot's seat is just aft of the engine in the frame, diagonals being omitted there for this reason, and this part is covered with canvas to keep out the wind.

In the Antoinette monoplanes, the whole scheme is entirely different. The frame is of bicycle steel; there are only three longitudinal members, and all the cross frames are triangles. The entire construction is covered with varnished white linen, not only giving a handsome solid appearance to the aëroplane as a whole, but the added weight of the canvas is more than compensated for by the gain in speed, due to preventing the friction of the air through all the wires and struts of the body. The main wing members are continuous, crossing the body to which they are secured by brazed joints, while the aviator sits in front of them, he and the motor being carried by extending the body forward of the wings. The wings are held rigid by wires attached to truss frames above and below the wings and body frame.

Among the biplanes there is the same diversity of opinion regarding material as in the monoplanes. The Farmans and Voisins have main frames of ash, with piano-wire tensions and turnbuckles, while the constructions of Clément-Bayard and Sommer are entirely in hollow bicycle steel. In all of them the screw is mounted just astern of the main planes, so that the spacing of the rear tailframe is fixed by the diameter of the screw, which is from seven to nine feet. In the Sommer plane the large experience of its designer has caused him to introduce a system of steel hinges for the joints of the struts with the main members, in place of brazing, to allow dismantling of enough of the frame to facilitate transportation. In all of them, except the Voisins, provision must be made for supporting the *equilibrieurs* or forward stability planes. As these are not less than 14 feet from tip to tip, they form a couple with the rear tailplanes to support considerable of the dead weight, in addition to controlling longitudinal stability, so the supports must have considerable strength. More-

over, the general tendency of any biplane is for the rear plane to rise first, and on landing, this adds to the couple tending to capsize it forward. To prevent accident to the mechanism of the forward planes, M. Sommer has curved the lower members of the triangular supporting trusses to form, in effect, the runners of a sled, which take the shocks before they do any damage to the planes. In his machines they are also spread at the same distance apart as the longitudinal members of the rear frame, being a continuation of them, and the truss is further strengthened by stout struts extending diagonally downward from the front edge of the upper main plane. In the Farmans this feature is wanting, and the stability planes are hinged by their main axes to form a cantilever, with the supporting trusses only a few feet apart at the middle.

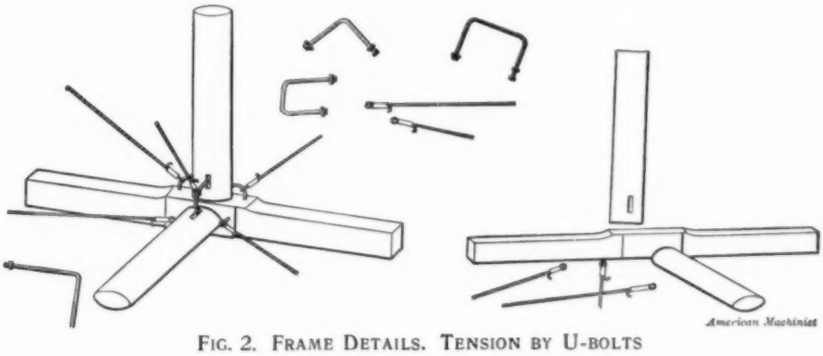


FIG. 2. FRAME DETAILS. TENSION BY U-BOLTS

In the Farman planes the rudders are swung vertically on either side of the rear tailplanes and moved by wires attached to a steel crossbar on each rudder. In the Sommer design the lower tailplane has been discarded in favor of the added sturdiness obtained by bending up the lower longitudinal members in the form of a sled runner. Without the counteracting effect of the forward stability planes, the rear planes have little portative capacity. In fact, the best economy can be gotten out of the motor by lodging all the portative effort in the main planes and reducing the areas of the forward and rear planes to the minimum needful to maintain stability. This appears to be the direction in which the latest designs are trending.

Elimination of the lower rear plane displaces the rudder to some other part of the apparatus, and M. Sommer's solution of this matter is simply to advance it further forward into the tailframe and swing it between the next two crossframes.

THE CHASSIS

To be a practicable vehicle, an aëroplane should be capable of alighting anywhere or leaving any level spot in the open fields. This desideratum has been carefully studied out by the French designers and embodied in different types in the various standard planes. As the tail is the last to alight, a mere wheel with deadening springs on its axis or a rudimentary shoe, as in *Demoiselle II* is sufficient. But under the main body, weighing from 500 to 1200 pounds, the chassis must have considerable deadening effect to avoid broken wheel spokes and buckled tires. They take two different styles: (1) Springs are placed on the shafts of the wheelforks with a large travel, the wheel frame being a hinged triangle, one side collapsible. (2)

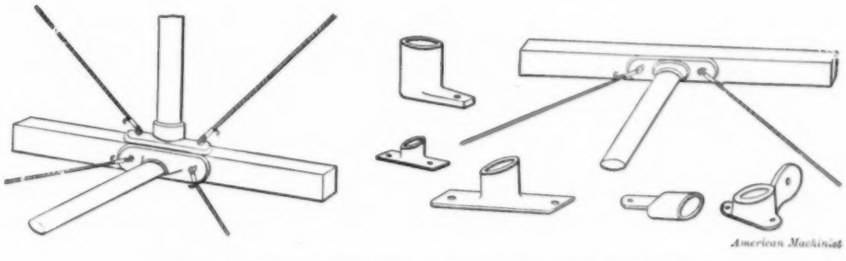


FIG. 3. FRAME DETAILS. TENSION BY TURNBUCKLES

A shoe of some sort strikes the ground first, whereupon its arm folds up under the resistance of a spring, and then the wheels come into play, they also being furnished with deadening springs.

In the Bleriots the chassis frame carries the main body frame inside of it. On its main uprights is a sliding collar, capable of about a foot of movement, and to this collar are pinned the diagonal struts of the fork. At the foot of the uprights are pinned the two horizontal forks of the wheel. These diagonal and horizontal forks form, with the uprights, a jointed triangle. When the aëroplane alights, the diagonals transmit the shock to the collar, which slides vertically upward against the compression of a powerful spring. In some of the other planes this spring is placed on the diagonal itself, but this has the disadvantage of requiring a stronger spring to resist the same shock, in the proportion of the secant of the angle betwen the diagonal and the upright.

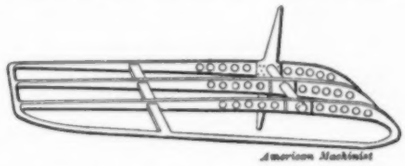


FIG. 4. BLERIOT WING FRAMES

In the Antoinettes, compressed-air pistons are used to absorb the shock of landing. Under the middle of each wing the struts for holding it rigid are extended downward and carry a small wheel at the extremity. Under the main body of the plane is a sort of skate, carrying two small bicycle wheels at its rear end, and a small solid wheel at the front. Both uprights connecting the skate to the main body have compressed-air pistons. On landing, the small wheel hits the ground first, and then the rear wheels come into play. In the biplanes there is ample room to make stout dispositions of the chassis, and the collapsible triangle with long springs is almost entirely used. In the Clément-Bayard they are replaced with pneumatic pistons which form the vertical member of the triangle.

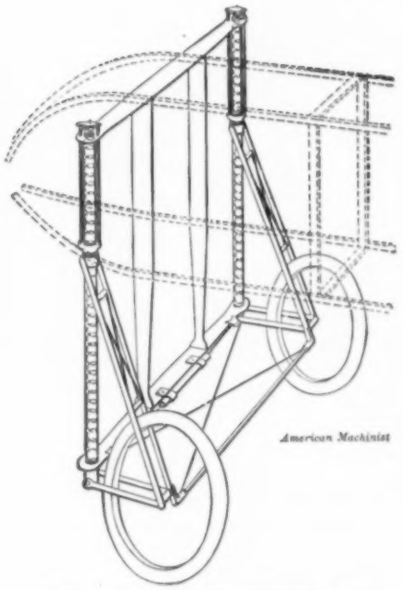


FIG. 5. CHASSIS OF BLERIOT XI

CONTROL MECHANISM

As stated at the beginning of this article, the pilot has five movements to make in managing his plane as it moves

through the air, and nearly all of them have to be made at the same time, with sureness and accuracy, if an accident is to be avoided. The rudder is almost invariably managed with the feet. The warping vanes are connected by one control, so that when one moves up, the other lowers, giving double the effect with one movement. The longitudinal stability-planes, whether in front or rear, require a lever, and there are the timer and the carbureter throttle, requiring their controls. A long apprenticeship is required to manage all these simultaneously without getting confused, and unless they are centered in one lever or in two at the utmost, one must have the versatility of a church organist to work so many different things at the same time.

In the Bleriots there is but one lever to manage lateral and longitudinal stability, and on it are mounted the timer and carbureter handles. The lever is universally jointed at its middle, and to the foot are attached the four wires which warp the main wings and the vanes of the rear plane, either simultaneously in the same direction or opposite. To counteract any tendency to dip, it is necessary simply to throw the lever in the opposite direction. In the Antoinettes there are three handwheels, all together on one shaft. One of them controls the longitudinal stability planes, the second, the rudder, and the third, the lateral stability vanes. All of them are under one hand and all three or any two can be moved at the same time. For opposite movement of the wheels, the other hand is brought into play. The motor is controlled by the feet. A pedal interrupter stops the motor, and the spark and carbureter are controlled by two small foot levers.

In the *Demoiselle II* the longitudinal stability vane is controlled by a lever at the right hand and the rudder by a small horizontal wheel at the left. The motor is managed by the feet and the warping of the wings for lateral stability is done by two wires, which are attached to the vertical stock of the pilot's seat. To counteract side dipping, it is simply needful to incline the body to the opposite side.

Among the biplanes the latest construction is to have all control wires in duplicate to assure safety. In general the steering is by the feet, warping and longitudinal stability by two levers at right and left, and control of the motor by handles on these levers. In the Farmans, however, the warping is by the vertical wheel so common in automobile construction; the steering is by the feet, and lateral stability by turning the automobile steering wheel to right or left, the forward stability planes being moved by leverage motion of the shaft of the wheel. All the joints of the wires and rods of command are ball bearing.

Study of Thermal Insulators for Cars

By C. R. Harris

Many of us have noted that steel passenger cars seem very cold in winter weather. A study has been made of several thermal insulators to determine their efficiency when applied to a metallic surface. Artificial lumber proved to be one of the best.

It is probably true that 90 per cent. of the thermal insulation of steel passenger cars has been done by applying a single thickness of insulation to the outer steel sheets of the car. This insulation has consisted of a textile fabric woven from asbestos and attached to the steel by the use of silicate of soda. I have never seen the results of any comparative tests of the insulating qualities of this material, and of other well known and often used materials.

Before the advent of the steel passenger car, the wooden car was universally used and standards had been worked out for properly heating such cars. These same standards were used in designing the heating equipment for steel cars and proved insufficient to maintain a temperature high enough for comfort in ordinary winter weather. With this condition confronting the designer of steel passenger cars, it would seem natural that a search should be instituted for some more efficient non-conductor of heat to reduce the cost of heating and to prevent excess drain of steam from the locomotive. I am not in a position to say that such investigation has not been made but I do know that the asbestos textile fabric is still being installed in the cars now under construction and that the two-inch steam pipe coils of the first cars have been superseded by cast-iron radiators having larger radiating surface and much greater weight. A step in this direction is manifestly wrong for economic reasons.

The cost of supplying steam to heat the cars is a burden which lasts the life of the car and the cost of heating excess weight likewise remains so long as the car is in service. In other words the steel passenger car equipment of today is placing additional burdens upon the locomotive, which cannot be easily borne and which can possibly be removed by substituting some other thermal insulator for the one now universally used.

Holding the belief that a mistake had been made as indicated above, I made tests last winter in an effort to establish the correctness or fallacy of such a belief. The results are shown by the accompanying charts and while they do not cover the field of thermal insulators they do point to the fact that the present passenger car can be much more efficiently insulated and at a lower first cost.

Apparatus Used in the Tests

Fig. 1 shows the apparatus used in mak-

Fig. 1. Apparatus Used to Test Thermal Efficiency of Insulating Materials for Steel Passencer Cars

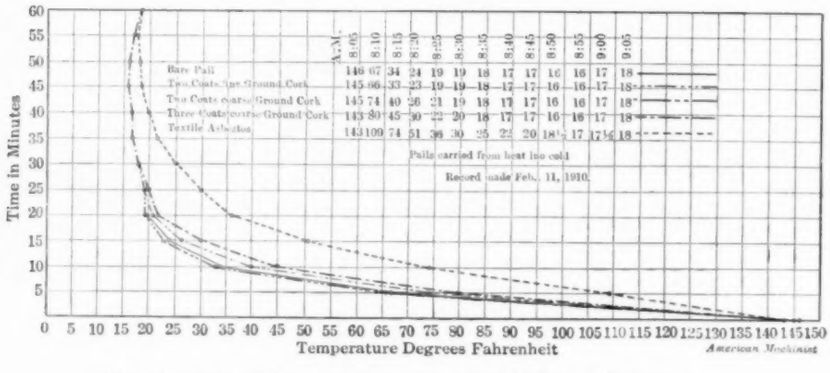


Fig. 2. Cooling Curves for Insulated Pails. See Fig. 1

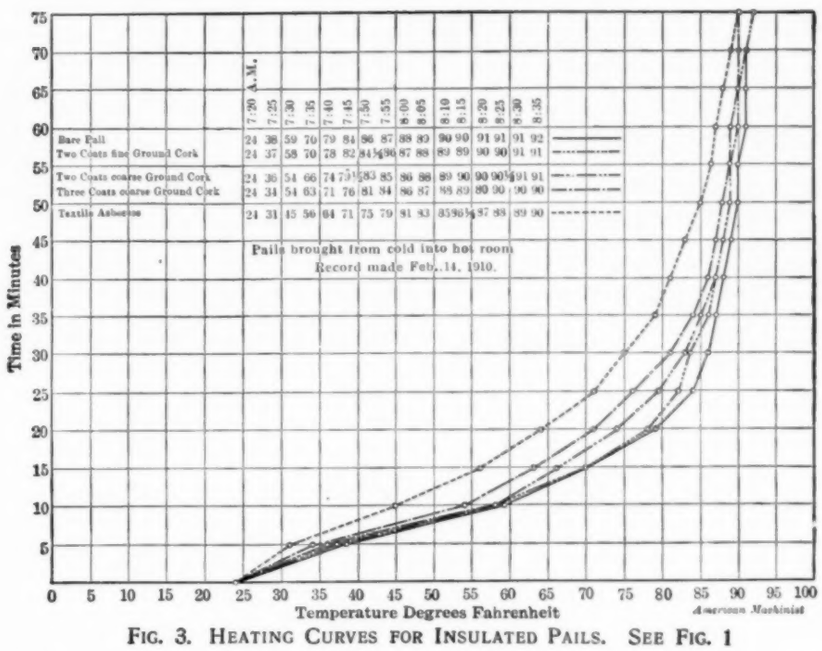

Time in Minutes
Temperature Degrees Fahrenheit
Pails brought from cold into hot room
Record made Feb. 14, 1910.
American Machinist

FIG. 3. HEATING CURVES FOR INSULATED PAILS. SEE FIG. 1

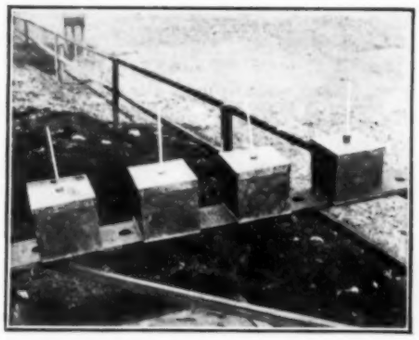


FIG. 5. ANOTHER TESTING APPARATUS

ing the tests from which data was obtained and curves plotted as shown in Figs. 2 and 3. One pail was lined with asbestos fabric; the second was coated with two coats of paint carrying a coarsely ground cork; third was given three coats of the same paint; fourth was given two coats of paint carrying a finely ground cork; the fifth pail was unlined. All the pails were coated with their respective coverings on all surfaces on the interior and no bare metal left for radiation.

Bare pail	0.918
Three coats of paint carrying coarse cork	0.918
Two coats of paint carrying coarse cork	0.918
Two coats of paint carrying fine cork	0.918
Asbestos textile fabric	1.108

FIG. 4. RATIO OF EXTERIOR SURFACE OF PAILS TO INTERIOR VOLUME OF AIR'

Each pail was equipped with a bottle cork, carrying a thermometer which could be read without removing the thermometer from the pail.

Tests were made by placing the pails over a radiator and then removing them to the open air and reading the thermometers every five minutes; also by placing the pails in the open air until cold and then bringing them into a heated room.

The advantages of a good thermal insulator which could be applied with a brush are evident but the results of this test are not such as to point to probable success in this direction.

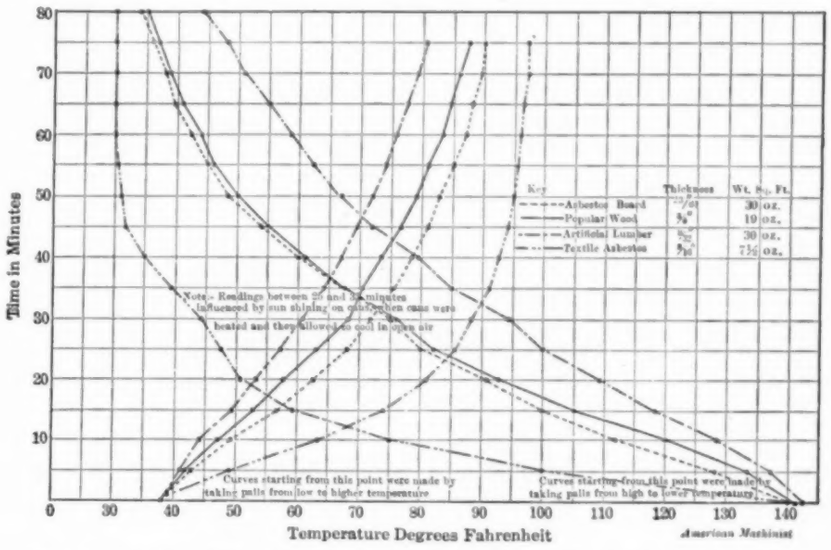

Time in Minutes
Temperature Degrees Fahrenheit
Key
Asbestos Board
Popular Wood
Artificial Lumber
Textile Asbestos
Thickness
Wt. per Sq. Ft.
30 oz.
19 oz.
30 oz.
Note.- Readings between 25 and 35 minutes influenced by sun shining on cabinet when cans were heated and then allowed to cool in open air
Curves starting from this point were made by taking pails from low to higher temperature
Curves starting from this point were made by taking pails from high to lower temperature
American Machinist

FIG. 7. COOLING AND HEATING CURVES FOR INSULATED BOXES. SEE FIG. 5

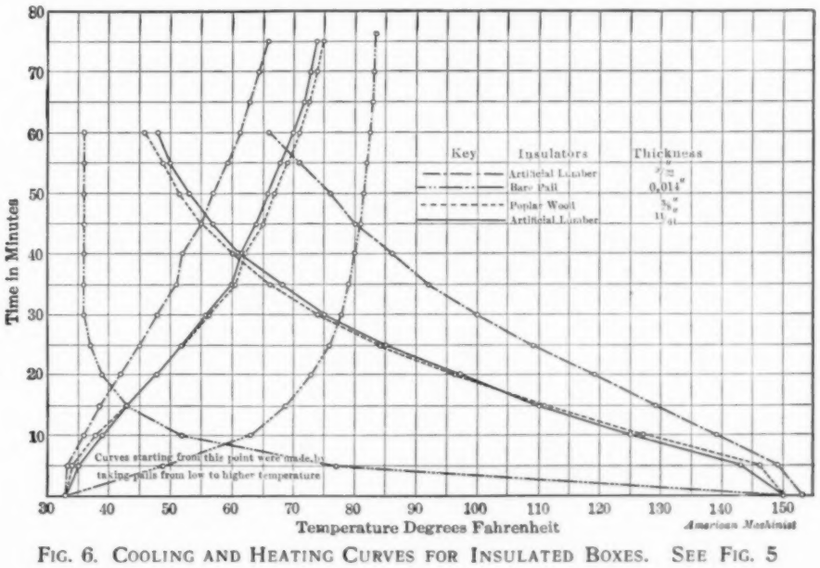


FIG. 6. COOLING AND HEATING CURVES FOR INSULATED BOXES. SEE FIG. 5

SOME INTERESTING RESULTS

Fig. 2 shows one very interesting point. The pail coated with the finely ground cork paint cooled faster than the bare pail. This result is undoubtedly due to the fact that the paint bond holding the cork is a good conductor of heat, and the particles of paint coated cork exposed a granular and therefore an increased surface, from which radiation took place.

Fig. 4 shows the ratio of the exterior surface of the pails exposed to the air, to the cubical contents of air. No allowance is made for thickness of paint or tin, but allowance was made for the decreased cubical contents due to thickness of the asbestos fabric.

ANOTHER APPARATUS

In order to make relative tests with non-flexible insulators cubical tin boxes were provided as shown by Fig. 5.

Fig. 6 shows the results of our series of tests. Between 30 and 40 minutes after the start of tests the sun came through a window and shown upon all boxes except the bare pail; this is shown by the bend in the curve at the thirty-fifth minute reading. As soon as the fact was observed that the sun was shining directly upon the boxes they were moved out of the sun's rays.

THE RESULTS

It will be noted that the 11/64-inch artificial lumber and the 3/8-inch dry poplar wood are not very far apart as thermal insulators with the artificial lumber the better non-conductor. It is interesting to note that apparently at the beginning of the test the 3/8-inch wood was going to make a better showing than the 11/64-inch artificial lumber, but that between 15 and 25 minutes after starting of the test, wood curve crosses the artificial lumber curve and from that point on the superiority of the artificial product is very evident. This condition was caused by the higher coefficient of thermal capacity of the poplar wood which for a time gave to the 3/8-inch lined box the extra necessary heat to keep the temperature above that of the box lined with 11/64-inch artificial lumber.

Unlined box	1.0
3/8-inch poplar wood lined box	1.492
7/8-inch asbestos board lined box	1.467
3/8-inch artificial lumber lined box	1.342
11/64-inch artificial lumber lined box	1.191
1/8-inch asbestos textile fabric lined box	1.210

FIG. 8. RATIO OF EXTERIOR SURFACE OF BOXES TO INTERIOR VOLUME OF AIR.

Fig. 7 shows another series without an unlined box. The sun rose during this test and shows in the curve of all boxes between 25 and 35 minutes after the test started. The effect is plainly shown on the curves.

Fig. 8 shows the ratio of exterior surface of the boxes exposed to air, to the cubical contents of air.

With the exception of the asbestos products none of the substances were fireproofed and this fact would bar its use on some lines for steel passenger work. If the wood and artificial lumber can be fireproofed, these experiments would seem to indicate that there is a field for great improvement in insulating steel passenger cars against cold in winter and heat in summer.

A German Oil Testing Machine

By Dr. Alfred Gradenwitz

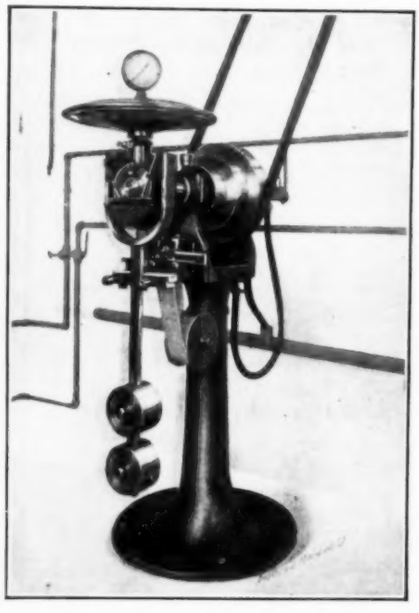
Based upon the principle that a bushing loosely mounted on a journal is advanced a certain distance in the direction of rotation depending upon the quality of the lubricant.

The oil-testing machine designed by Professor Martens for the Royal Testing Office at Gross-Lichterfelde, is based on the fact that a bushing loosely mounted on a journal lubricated with the oil to be tested, is carried along in the direction of rotation through a distance dependent upon the lubricating value of the oil.

This machine, as presented in Fig. 1, consists mainly of a journal fitted to a horizontal shaft, with a pendulum mounted on the journal. The hollow shaft is traversed by an attachment for cooling the journal. The deflections of the pendulum are automatically recorded.

The testing journal, 100 millimeters (four inches) in external diameter and 70 millimeters (2.8 inches) in length, is made of steel of remarkable toughness and density, and is uniformly hardened in oil. The surfaces are ground with extraordinary care and highly polished. The journal is set accurately horizontal in order to keep the pendulum in its central position. A three-step belt pulley allows the journal to be run at 100, 200 and 400 revolutions per minute, respectively. The bushings of the pendulum are carefully ground so as to fit as accurately as possible on the journal, and should be kept running under a continual supply of oil and Paris red until a number of tests with absolutely pure oil under identical conditions will give pendulum deflections as identical as possible.

The friction coëfficient is measured by the deflection of the pendulum body suspended from the testing journal. The head of the pendulum is so designed as to receive the three bushings and the pressure generator. The bronze bushings are 20 centimeters (8 inches) in width, the two lower ones being rigidly connected with the pendulum head, and each perforated with a hole 8 millimeters (0.32 inch), in width, which serves to receive a thermometer bent at right angles. The upper movable bushing, which is guided in the pendulum head, comprises two fittings, which allow the pendulum to be shifted through four millimeters in its longitudinal axis. Funnel-shaped openings in these fittings prevent any projection of oil, by carrying the oil back to the lubricating bath.



A GERMAN OIL TESTING MACHINE

The thrust on the lubricating layer is produced by a Napoli pressure generator and is read from a gage. The upper bushing is secured against any lateral displacement in the pendulum itself by two screws fixed sideways, and can be removed for the sake of cleaning the journal and bushing. The two lower bushings, which are rigidly fixed to the pendulum, encompass the journal so closely as to leave only a space 0.5 millimeters (0.02 inch) in width, which is readily filled in by the oil to be tested, thus insuring an ample lubrication of the upper bushing. In order to make the lubrication as efficient as possible, the journal is immersed in the oil bath to a depth of 5 to 10 millimeters (0.2 to 0.4 inch). As the latter is provided with double walls, hot and cold water or steam can be introduced at will. A bow-shaped fitting on the pendulum carries the pendulum rod. The distance of the pendulum disk, 12 kilograms (26 pounds) in weight, from the central line of the journal to be tested, is read from a centimeter scale on the pendulum rod. The weight of the whole pendulum, exclusive of the disk, is compensated for by the counterweight fixed to the end of the rod. The edges of the three bearings at which the lubricating oil penetrates below the surfaces is slightly broken (0.5 millimeters or 0.02 inch) in order to prevent a premature removal of the oil.

The pendulum deflection is ascertained from the displacement of a slide guided on idlers, and carried along by the pendulum through a slot and crank. This slide comprises a scale taking the constants of the machine into account.

The readings should be multiplied by a factor depending on the magnitude of the pressure, and the distance of pendulum line from central line of journal.

Winding Flat Copper Strip Coils

Editorial Correspondence

A device designed to attach to an ordinary lathe for winding electric coils of flat strip copper. These coils, which are used in large electric machinery, have been very hard to wind because of the thinness of the copper and the consequent tendency to upset in turning corners.

The new device consists of a forming mandrel having a flange to carry a bending saddle which is hinged to a weighted lever. The copper strip is pinched between the side of the saddle and the flange of the mandrel and the tendency of the coil to unwind, when free, is overcome by making the mandrel in two parts hinged together, with suitable shoulders on the flange and by properly dimensioning the parts for the spring of the material.

One of the many problems which modern engineers have been called upon to solve in the construction of the larger sizes of dynamo electric machines has been that of designing a form of field winding that would carry a large enough current to produce the desired excitation without excessive rise in temperature. The earlier forms of winding, which consisted of several layers of wire built up one on another, proved inadequate, because the material which it was necessary to use in insulating the electricity was also a first-class insulator of heat. As a result, while the temperature of the outer layer might be well within the necessary limits, the heat produced in the coil in the central portion of the windings could be sufficient to harm the insulation and cause short circuits of grounds.

The idea was finally conceived of using in place of the copper wire, copper strips of equivalent cross section and resistance, and winding them on edge. With this arrangement there is a portion of each conductor that is in direct contact with the outside air. The resulting radiation of heat is greatly improved and, as copper is a good heat conductor, a practically even temperature is maintained throughout the coil. Practice has since proved that for the larger types of field windings requiring conductors of correspondingly large cross sections, this is practically the only efficient construction.

The greatest and practically the only objection to this form of winding has been in the mechanical difficulties encountered in winding the coil. It is necessary for the strips to be wound tightly and at the same time any excessive tension must be avoided, as this would result in stretching the conductors and decreasing their cross section.

Considerable pressure must be applied in order to fit the strips exactly to the shape of the core, but if excessive, it will result in upsetting the edge of the strip. In addition to this, the coils have a tendency to unwind slightly after the manner of a clock spring, when the tension is removed. This tendency is particularly hard to provide for in the case of rectangular or elongated coils.

For these reasons a peculiar interest attaches to a device that has been invented by Cano Dunn, chief engineer of the Crocker-Wheeler Company, Ampere, N. J. This machine has overcome all the difficulties outlined above, and has done so for the most difficult types of coil, where the conductor is as thin as 0.012 inch, with a width of over an inch, or where it was necessary to bend the strip into curves having radii as short as twice the width of the metal. In addition to the above attainments, even rectangular coils are produced without any thickening whatever at the curved portions, so that when the coils leave the machine they require no further treatment other than insulating, before their application to the field or transformer core.

Attached to Lathe

The device is attached to the faceplate of an ordinary lathe. As will be seen from the illustrations, it consists essentially of a split mandrel revolving about a fixed axis, and a saddle which presses the copper strip into position about this mandrel. The strip is applied to the mandrel from such a direction as to form a line about tangent to its surface at the point of entrance under the saddle. As the mandrel and saddle have movements independent of each other, this line in all but circular coils is constantly varying in its distance from the axis of the former, and also oscillating through a considerable angle. The extent of this angle may be judged approximately, by comparing the directions *x a*, along which the strip passes to the coiling apparatus, in Figs. 4 and 5, though these are not the extreme positions. In order to maintain the proper tangential relation, a guide *L*, Figs. 3, 4 and 5, is used, which is rigidly attached to the saddle and leads the copper strip from the reel,

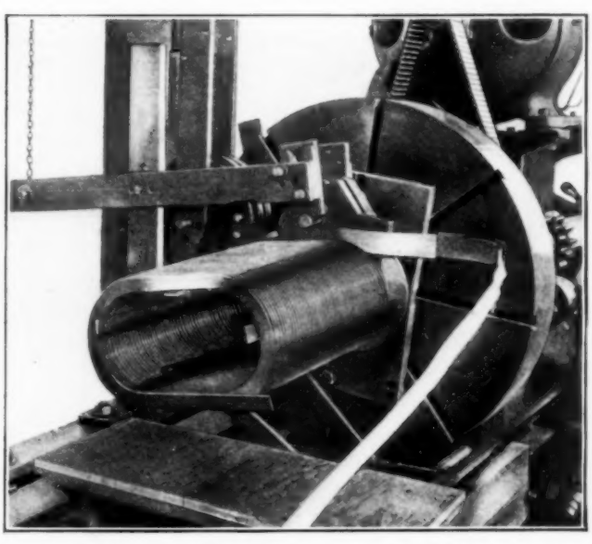


Fig. 1. Device for Winding Coils of Flat Copper Strip

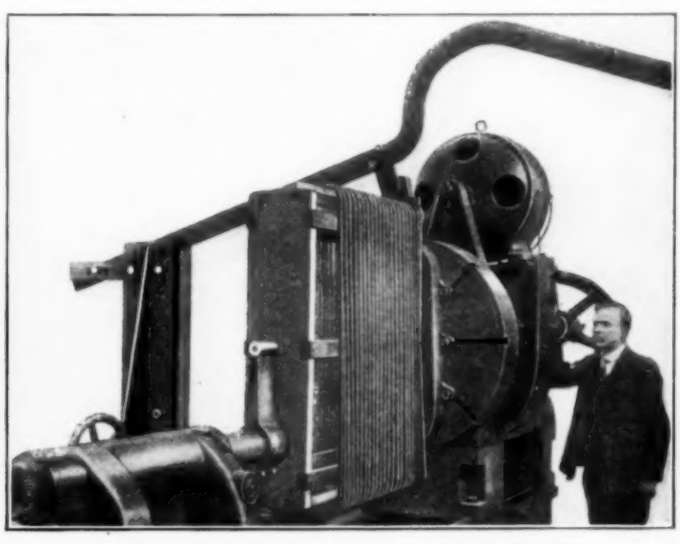


Fig. 2. Arranged for Elongated Coil Showing Pressure Lever

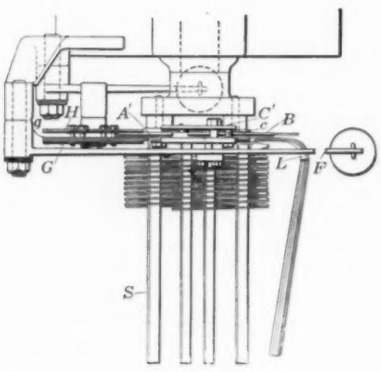


FIG. 3. PLAN VIEW

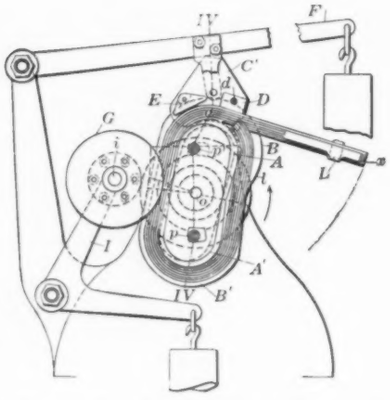


FIG. 4. END VIEW BENDING COPPER STRIP AROUND END

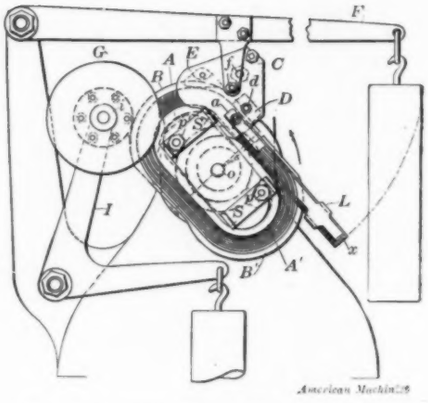


FIG. 5. LAYING STRIP ALONGSIDE OF COIL

around an arc which is slightly more than a right angle.

OVERWINDING

The mandrel is constructed of two pieces, as will be seen from Fig. 9, and these parts are joined together, being pivoted at the point *O* and having a slight angular and lateral movement with reference to each other. The object of this movement is to slightly overwind the coils and thereby allow for their springback, which has the effect of unwinding them slightly, after their release from the pressure exerted in forming them. Each mandrel part is constructed with a single flange provided with a shoulder, slightly narrower than the width of the copper strip to be coiled. The strip is delivered so that one edge is pressed against the top of the shoulder and one side against the face of the mandrel.

The bending saddle is applied as illustrated in Fig. 4, 5 and 8, and by exerting a constant sidewise pressure, holds this strip against the mandrel. It consists of two clamps *C* and *C'*, held together by bolts, and of a leading and following shoe, *D* and *E*, each operating on a pivot and exerting constant pressure on the copper. Both of the shoes are made slightly narrower than the width of the strip, so that their motion will not be restricted when the clamps *C C'* of the saddle are adjusted to hold the copper strip rigidly in place. The bending is effected by the leverage produced between the leading shoe and the shoulder on the flange of the forming mandrel. The copper is confined in the space between the leading and the following shoe by the face of the mandrel flange on one side and by one clamp *C* on the other side. In order that the tension on the sides of the copper strip may be as nearly uniform as possible, one of the clamps *C'* of the saddle, is faced with a strip of sheet metal, backed by a piece of hard rubber, the elasticity of this material tending to equalize the pressure. This does away with the possibility of any bowing and the following shoe *E* prevents any of the effect of bending from being transferred to the copper strip in the rear of the saddle.

The pressure of the bending saddle is maintained by a weighted lever *F*, which is connected with the mandrel at a point in the saddle midway between the shoes, so as to equalize the pressure of the

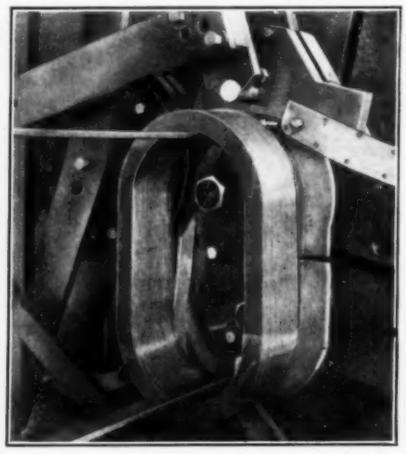


FIG. 6. VIEW SHOWING GUIDE WHEEL

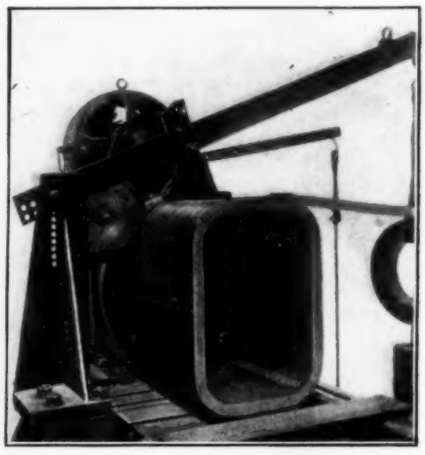


FIG. 7. WINDING RECTANGULAR COIL

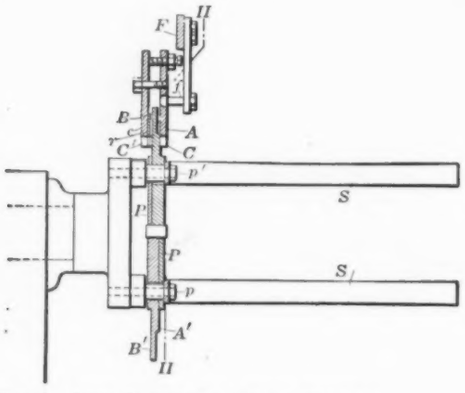


FIG. 8. SIDE ELEVATION. PART SECTION THROUGH BENDING SADDLES

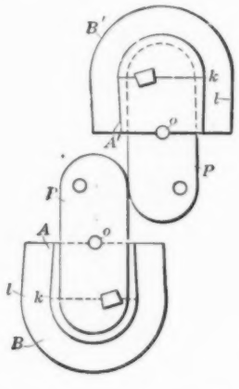


FIG. 9. TWO-PART MANDREL

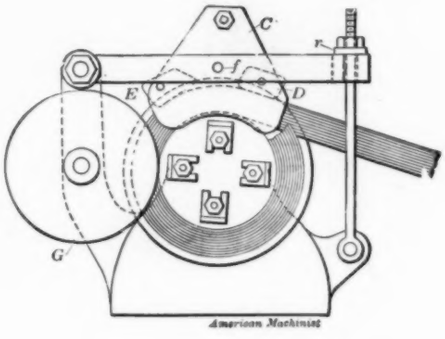


FIG. 10. ARRANGEMENT FOR ROUND COILS

two shoes upon the strip. If the full weight that is applied to the leading shoe were allowed to press directly upon the copper strip at the point of bending, upsetting would often result. This danger has been avoided by providing a small roller *d* on the axle of the leading shoe *D* and building the flange of each mandrel part with a slight shoulder *l*, Fig. 9, at the point where the bending occurs. The roller rests upon the edge of the flange and sustains the entire pressure of the weighted lever. The construction of the shoulder produces a more gradual bending of the strip. There is an instant, however, just after the leading shoe passes the shoulder when the whole pressure of the weighted lever is brought to bear on a portion of the copper strip which has not been brought down to the mandrel. If the weight is too great, it results in a sudden pressure, which upsets the copper at this point.

The Pinch Wheel

The strip is anchored firmly to the mandrel at all times, by means of a pinch wheel *G*, having two circular flanges. It passes between these two flanges immediately after emerging from under the bending saddle and here, as with the bending saddle, provision is made to maintain a uniform pressure by facing one of the flanges with rubber and sheet metal. This in indicated in Fig. 3. The pinch wheel is constantly pressed against the flange of the mandrel by means of a weighted bell-crank lever.

The unwind of the coil is allowed for as mentioned above by constructing the mandrel in two pieces with a slight lateral motion relatively to each other. It has been found in bending the copper strip around a mandrel of the shape shown in Figs. 4 and 5, the spring back caused by the elasticity of the metal tends to enlarge each of the arcs about ½ to 1 per cent., and to extend the straight portions from 1 to 3 per cent.

The tendency to enlarge the size of the arc and to shorten it slightly, which results from the elastic properties of the copper, has been provided for by making the mandrel slightly smaller than the core on which the coil is to be placed, and by making the arc of the mandrel shoulder about 181½ degrees, instead of 180 degrees, with the straight sides tangent to the ends of the arc. The tendency of the sides of coils to lengthen slightly after being removed from the mandrel has been allowed for by the slight movement that each mandrel part has with regard to the other. In this way the coils are wound with slightly shorter sides, with arcs slightly smaller in diameter end at the same time of greater length than is desired in the finished coil. The spring back settles the coil into exactly the necessary form.

Where the coils, instead of consisting of two-semi-circles joined by straight sides, are made up of four straight sides joined by 90-degrees arcs, the same principle is used, but each arc is carried out to 91 degrees instead of 90 degrees. Both of these types of mandrel are supported from the faceplate of the spindle by the two pins *p p'*. The center pin *O*, which hinges the parts together, is not directly connected to the spindle. The two portions are arranged to flap together and to make a tight joint at the receiving side of the mandrel just before the strip is applied. The pressure of the lever on the mandrel is so applied as to force it to assume this position at just the right time.

A Handy Radial Drill

By John P. Faber

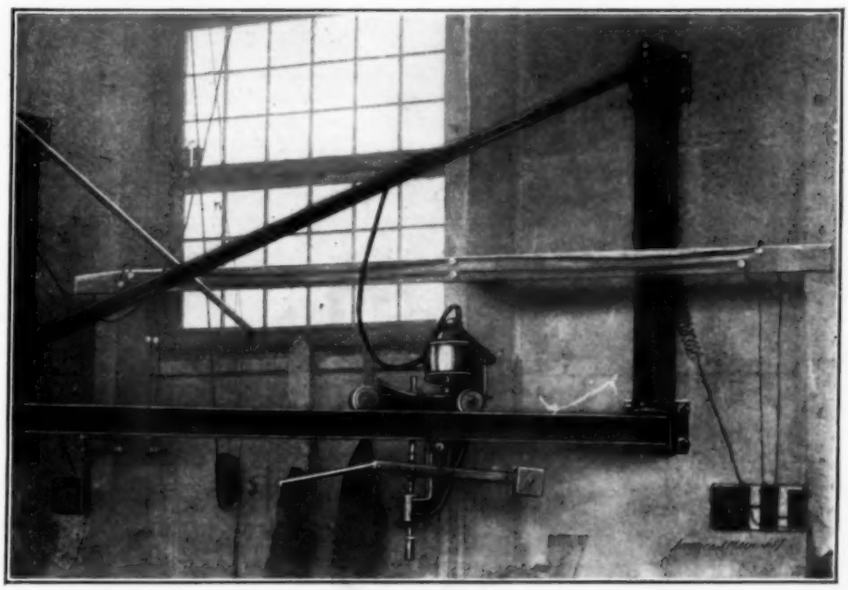
The radial drill described below is unique in the directness of the application of power to the drill spindle and in the simplicity and small number of its parts. As will be seen from the illustration, the drill is of the general type known as a boilermakers' drill and countersink, consisting of a bed plate bolted to the wall and carrying a swinging boom upon which travels a carriage carrying the drill spindle. But while the standard tool is driven by a series of vertical and horizontal splined shafts involving the transmission of power through no less than three sets of bevel gears, this machine has a motor mounted directly on the carriage and driving the spindle through a single pair of spur gears.

The vertical shaft of the motor carries a pinion at its lower end, meshing with a large gear through the hub of which the spindle is free to slide and which drives the spindle by means of a feather. The upper part of the carriage casting forms a casing for the gears and is covered by a thin plate held in place by the yoke, which also serves to keep the large gear from being forced upward by the movement of the spindle.

The carriage traverses on small flanged wheels and is clamped at any point by an eccentric and lever. The feed is by hand through a lever with yoke and ball-thrust collar, having a vertical movement of six inches. The bedplate and arm are of structural steel, with a casting for the hinge, the same casting being used both top and bottom. The castings carrying the mechanism are simple and few in number, with the machine work reduced to a minimum. The spindle bearings are bronze bushed.

This machine was built for one kind of work only, namely the rapid drilling of 9/16-inch holes in soft steel plate, and was therefore equipped with a 1½-horsepower constant-speed motor, geared for a speed of 300 revolutions per minute of the drill. For general use, however, a 3 to 1 variable-speed motor would give it a range from ⅜ to 1⅛ inches.

This machine was a strictly "home-made" one and the objective points in the design were to produce a drill with the fewest possible number of parts, and these of the simplest character permitting of their finishing on the ordinary machine tool found in all shops and by unskilled help.



A Handy Radial Drill

Twisted "Straight Edges"

By Oscar J. Beale

It is possible to make straight-edges, three at a time, with twisted surfaces which will fit together without the warped nature of the surface being revealed until one piece is swung diagonally upon the other.

Some interesting models milled up between centers show how two pieces with spiral surfaces go together endwise with perfect contact.

How the pieces were held, machined and tested.

In trying to make long straight-edges, two or three inches wide, by carrying along three at a time, according to the well known method, *twisted* "straight-edges" have sometimes been made instead of "*straight-edges*". Three twisted straight-edges are illustrated in Fig. 1. If, in scraping, a twist is started in one plate, or straight-edge, it may be copied in the others. So long as one twisted "straight-edge" is moved lengthways upon another, as in Fig. 2, their twisted character may not be disclosed, inasmuch as any one of them may fit each of the two others. But, if they are wide enough to allow one to be placed diagonally upon another, as in Fig. 3, their twisted character is at once disclosed. It is better to test a straight-edge with a wide surface plate that is as long as the straight-edge to be tested.

No Use for the Twisted Edge

In the strict use of terms, a *straight-edge* cannot be a *twisted* edge.

We cannot make any use of a twisted edge. There is an old story of a scythe-maker's telling an apprentice that if he should happen to make a sickle, when trying to make a scythe he would better not spend any more time on it, but let it remain a sickle. We cannot be so fortunate, if we happen to make a twisted-edge, when trying to make a straight-edge, for, if there is stock enough left, we must keep right on trying until we have made a straight-edge.

Three Twisted Models

The three pieces in Fig. 1 have been surfaced in a Brown & Sharpe universal milling machine, in order to show that a certain class of twisted, or warped surfaces can fit one another, as in Fig. 2, and interchange somewhat like straight-edges. They have been scraped to fit one another as accurately as good surface plates fit.

The blanks for these pieces were shaped like Fig. 4, with lugs *A* and *B* containing center holes to allow them to be mounted upon the spiral milling centers. They were surfaced with a small mill *M*, about half an inch diameter, the mill cutting just down to the center line. The spiral spindle was geared to cut a spiral of about 149 inches lead. Strictly, a mill *M* of sensible diameter will not mill two spiral or warped surfaces that will fit each other exactly, which fact is well known to users of Brown & Sharpe milling machines; this lack of exactness may not be noticed when the lead is as long as 149 inches. After surfacing the length between *C* and *D*, the lugs *A* and *B* were cut off.

The Straight-edge on the Warped Surface

The three pieces in Fig. 1 belong to a class of warped surfaces in which there is in every piece one straight line in one direction, and the same surface is made up of innumerable straight lines crossing the one straight line at right angles. In other words, a thin straight-edge will fit a surface along the one straight line as at *F G*, and the same thin straight-edge will fit the surface in every position that is at right angles to the one straight line, one of the positions being shown at *H I*, Fig. 5.

If we suppose the piece *J K* to be mounted between the centers of a universal miller, and the straight-edge *H I* held stationary in the main spindle, while the spiral head is moved endways with

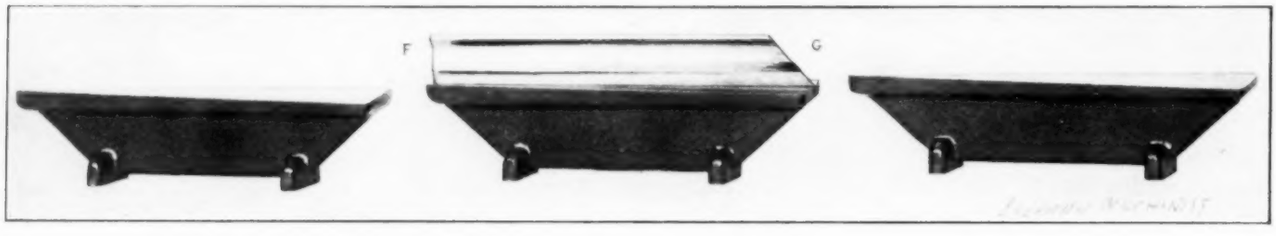


Fig. 1. Three Twisted Straight-edges

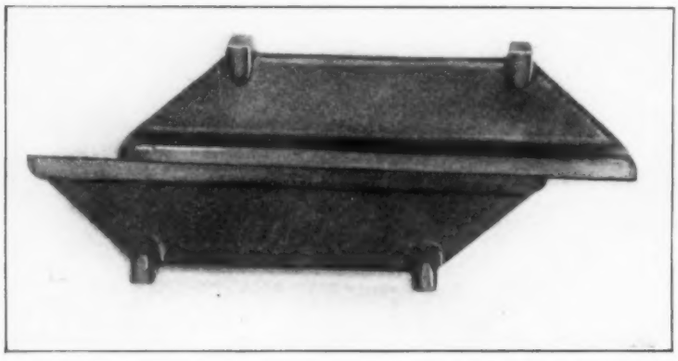
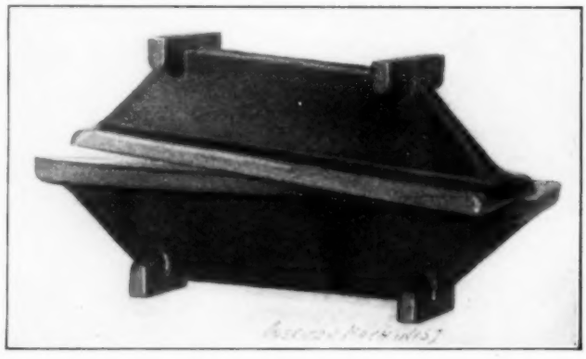


Fig. 2.



Two Twisted Surfaces in Contact with Each Other Fig. 3

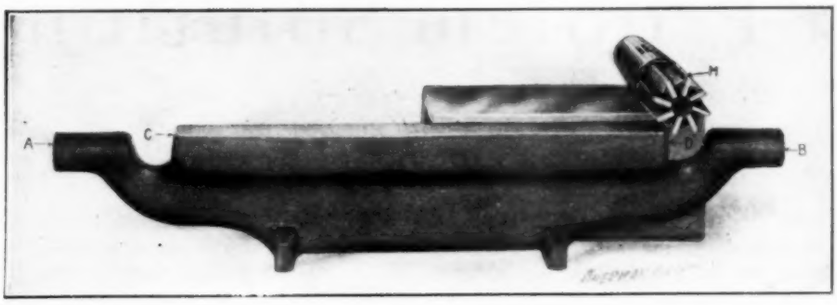


FIG. 4. THE ORIGINAL BLANK AND THE CUTTER

the table, and the head is geared to cut a spiral, we at once conclude that the straight-edge will cut the surface of *J K* so that every cross line will be straight, corresponding to the straight-edge itself.

AN EXTREME EXAMPLE

The two pieces in Fig. 6 are milled on the same principle as the pieces in Fig. 1, only Fig. 6 has a lead of not more than about four inches, so that the spiral or warp is cut up longer than the lead, or more than a full turn. These two pieces can be screwed together, each piece forming a nut for the other.

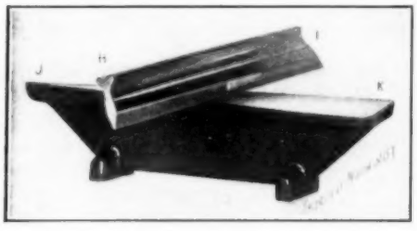


FIG. 5. THIN STRAIGHT-EDGE APPLIED CROSSWISE OF WARPED SURFACE

Fig. 7 shows one of these pieces separated from the other. The straight line in every cross-section is indicated in the end view, Fig. 7, at *L M*. These pieces are precisely similar to Fig. 1 in having one straight line in the surface and innumerable straight lines crossing the one straight line at right angles. One of these cross lines is indicated at *L M*.

The foregoing is of interest in a machine shop, as showing how a warped surface may unintentionally be produced and also showing how to avoid the production of a warped surface. A further consideration brings us to some rather peculiar geometry which may interest the technical student.

A GEOMETRICAL CONSIDERATION

In works on geometry we are told that two straight lines that intersect determine the position of a plane, because only one plane can be passed through the two straight lines. But, because two intersecting straight lines are in a surface we cannot conclude that this surface is a plane, for these same lines may be in innumerable warped surfaces and in innumerable cones.

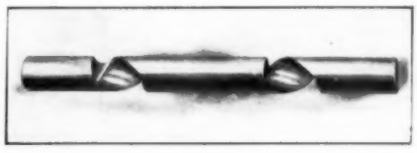


FIG. 6. HOW TWO SPIRALLY MILLED PIECES FIT TOGETHER

I have already spoken of a class of warped surfaces, Fig. 1, that contain one straight line in one direction and innumerable straight lines crossing this one straight line at right angles. This one straight line and each of the cross lines must be at right angles in order to have the surfaces interchangeable. Any one of the pieces in Fig. 1 and in Fig. 2 can also be reversed, end for end, and still interchange with any other of these pieces. This one line and a cross line intersect and they are in the surface, but this surface is warped and is not a plane.

It is evident that any two intersecting straight lines can be in the surface of any cone whose apex angle is as great or greater than that formed by the intersecting lines. The lines intersect at the apex of the cone.

FITTING WARPED SURFACES IN PAIRS

Figs. 8 and 9 illustrate how two warped surfaces can be milled so that they will fit each other in pairs. If two surfaces are milled in the same way, they will not fit each other and consequently three surfaces will not interchange. These two surfaces differ from Fig. 1 in having the cross lines diagonal instead of at right angles, which is produced by swinging the spiral bed around, first one way for one surface and the other way for the other surface. In order to have two diagonally milled surfaces fit in pairs, the angular setting of the spiral bed in one direction must equal the angular setting in the other direction.

NECESSITY OF MODELS

The truths just spoken of are in the nature of postulates and any attempt to prove them without models may lead to more confusion than clearness. A machinist would appreciate these truths and would act upon them without question.

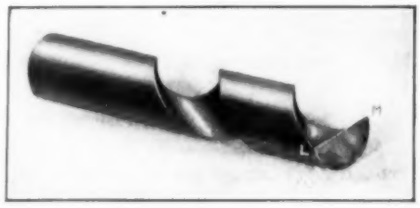


FIG. 7. ONE OF THE SPIRALLY MILLED PIECES

Other warped surfaces can be devised that will go together in pairs and will also interchange in pairs, but one piece cannot be reversed, end for end, and still fit any other piece. As such surfaces have no interest in a machine shop, I will not illustrate any of them, at this time.

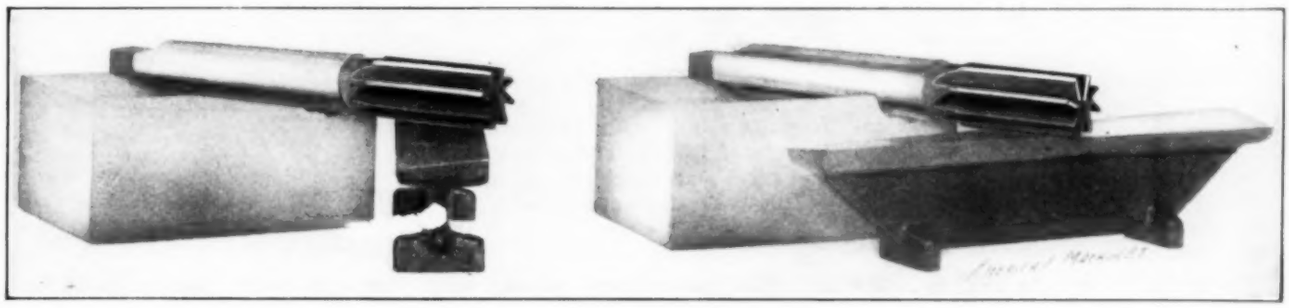


FIG. 8. HOW WARPED SURFACES ARE MILLED TO FIT EACH OTHER IN PAIRS FIG. 9

Spiral Gear Problem Solutions

By A. E. Thayer*

Mathematical solutions not generally well known with natural functions of angles, secant and co-secant. Tables and curves showing values

Given the center distance, the speed ratio, and the diametral pitch of a pair of spiral gears, many solutions are possible. There are two remaining factors, either one of which, except when the axes of the gears are parallel, will give the required conditions for a single solution: First, the approximate pitch diameters of the two gears, and second, the tooth helix angles. Only one of these last two factors can be selected, as the values of one with the center distance, speed ratio, and pitch given, determine the values of the other. When the axes of the spiral gears are parallel, the pitch diameters are proportional to the speed ratio or numbers of teeth, and the tooth helix angle always has to be selected. The center distance must be taken as approximate if the tooth helix angles are fixed, and the tooth helix angels must be selected as approximate if the center distance is fixed.

Generally, when any pair of spiral gears is ready for solution the center distance has been determined either approximately or fixed, and the speed ratio and pitch have been decided on. Also, certain conditions dependent on design, will have determined whether the approximate pitch diameters or the tooth and cosecant, as well as the sine, cosine, helix angles will be selected. These selections form the basis on which this work has been subdivided into cases.

In order to make use of the following solutions, it is necessary to have a table of the natural functions of the angle, and this table must include the secant tangent and cotangent. Some of the formulas may be more easily solved by the use of the logarithmic functions of the angle and logarithms of numbers, but their use is not necessary.

*Chief draftsman, Pratt & Whitney Company.

α = Tooth helix angle of follower.
C = Center distance of axes.
N = Number of teeth in driver.
N' = Number of teeth in follower.
R = Speed ratio $= \frac{N}{N'}$.
D = Pitch diameter of driver.
D' = Pitch diameter of follower.

Case	Angle of Axes = B	Speed Ratio = $\frac{N}{N'} = R$	Diametral Pitch of Cutter = P	Centre Distance = C Approximate	Centre Distance = C Fixed	Approximate Pitch Diameters = D and D'	Tooth Helix Angles = ϕ and α Fixed.	Tooth Helix Angles = ϕ and α Approximate
I	given	given	ginen	given		given		
II	given	given	given		given	given		
III	given	given	given	given			given	
IV	given	given	given		given			given
V	90°	given	given	given		given		
VI	90°	given	given		given	given		
VII	90°	given	given	given			given	
VIII	90°	given	ginen		given			given
IX	0°	given	given	given			given	
X	0°	given	given		given			given

TABLE SHOWING SUB-DIVISION INTO CASES.

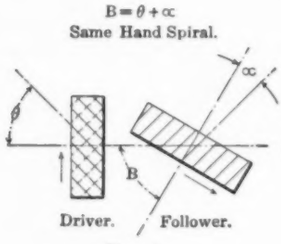


FIG. 1

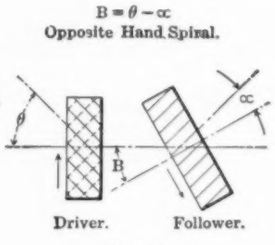


FIG. 2

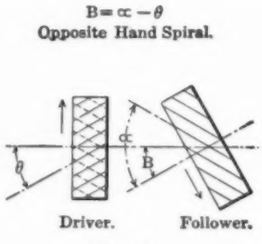


FIG. 3

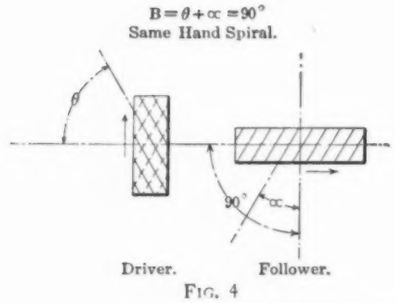


FIG. 4

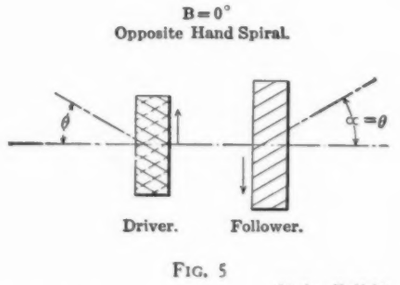


FIG. 5

American Machinist

MATHEMATICAL SOLUTION OF SPIRAL GEARS

NOTATIONS OF FORMULAS

B = Angle of axes between driver and follower.
ϕ = Tooth helix angle of driver.
$O\,D$ = Outside diameter of driver.
$O\,D'$ = Outside diameter of follower.
P = Diametral pitch of cutter.
L = Lead of tooth helix angle of driver.
L' = Lead of tooth helix angle of follower.
T = Number of teeth for which cutter is selected for driver.
T' = Number of teeth for which cutter is selected for follower.
$\pi = 3.1416$.

Cases I, II, III and IV

Angle of axes between O° and 90°

(Figs. 1, 2 and 3)

Cases I and II. (Preliminary Solution)

Given

B = Angle of axes.
C = Center distance of axes (Case I approx., Case II fixed).
D and D' = Approximate pitch diameter of gears.
R = Speed ratio $= \frac{N}{N'}$.
P = Diametral pitch of cutters.

Solve for trial value of ϕ

$$Tan.\,\phi = \left(\frac{D}{D'R}\,cosec.\,B - cot.\,B\right)$$

for Figs. 1 and 2.

$$Tan.\,\phi = -\left(\frac{D}{D'R}\,cosec.\,B - cot.\,B\right)$$

for Fig. 3.

If $\left(\frac{D}{D'R}\,cosec.\,B - cot.\,B\right)$ is positive

and ϕ is less than B, the conditions are as shown in Fig. 1.

If $\left(\frac{D}{D'R}\ cosec.\ B - cot.\ B\right)$ is positive and ϕ is greater than B, the conditions are as shown in Fig. 2.

If $\left(\frac{D}{D'R}\ cosec.\ B - cot.\ B\right)$ is negative, the conditions are as shown in Fig. 3.

Solve for N and N'

$$N = DP\ cos.\ \phi \qquad N' = (D'P\ cos.\ \alpha) = \frac{N}{R}$$

Take the nearest whole values of N and N' which will give the desired value of R.

Cases III and IV. (Preliminary Solution)

Given

B = Angle of axes.

ϕ and α = Tooth helix angles (Case III fixed) (Case IV approx.).

C = Center distance of axes (Case III approx.) (Case IV fixed).

R = Speed ratio $= \frac{N}{N'}$

P = Diametral pitch of cutters.

Solve for N and N'.

$$N = \frac{2CP}{sec.\ \phi + \frac{sec.\ \alpha}{R}} \text{ or } N = \frac{2CPR}{R\ sec.\ \phi + sec.\ \alpha}$$

$$N' = \left(\frac{2CP}{R\ sec.\ \phi + cosec.\ \alpha}\right) = \frac{N}{R}.$$

Take the nearest whole values of N and N' which will give the desired value of R.

Case I (Continued)

Take any selected angle approximately equal to the value of ϕ obtained in the preliminary solution and solve for α.

$\alpha = B - \phi$ (Fig. 1). $\alpha = \phi - B$ (Fig. 2).

$\alpha = \phi + B$ (Fig. 3).

Cases II and IV (Continued).

Solve by trial for correct values of ϕ and α.

$$sec.\ \phi + \frac{sec.\ \alpha}{R} = \frac{2CP}{N},$$

$$R\ sec.\ \phi + sec.\ \alpha = \frac{2CP}{N'},$$

or

$$N\ sec.\ \phi + N'\ sec.\ \alpha = 2CP.$$

Note—If R is less than $\frac{1}{4}$ and a simple ratio like $\frac{2}{3}$ or $\frac{1}{2}$, the best formula to use is $\left(sec.\ \phi + \frac{sec.\ \alpha}{R}\right)$. If R is greater than $\frac{1}{4}$ and a simple ratio like $\frac{3}{4}$ or $\frac{1}{4}$, the best formula to use is $(R\ sec.\ \phi + sec.\ \alpha)$. If R is a more complex ratio like $\frac{7}{8}$ or $\frac{15}{16}$, the best formula to use is $(N\ sec.\ \phi + N'\ sec.\ \alpha)$.

Case III. (Continued)

Take the fixed values of ϕ and α as given in the preliminary solution.

Cases I, II, III and IV. (Final Solution)

Solve for D and D'.

$$D = \frac{N}{P}\ sec.\ \phi. \qquad D' = \frac{N'}{P}\ sec.\ \alpha.$$

Solve for C.

$$C = \frac{D + D'}{2}.$$

Note—In cases II and IV this should exactly equal the value of C as given in the preliminary solution, and any discrepancy shows an error in the work.

Solve for $O\,D$ and $O\,D'$

$$O\,D = D + \frac{2}{P}. \qquad O\,D' = D' + \frac{2}{P}.$$

Solve for L and L'

$$L = \pi D\ cot.\ \phi = \frac{\pi N}{P}\ cosec.\ \phi.$$

$$L' = \pi D'\ cot.\ \alpha = \frac{\pi N'}{P}\ cosec.\ \alpha.$$

Solve for T and T'

$$T = \frac{N}{cos.^3\ \phi} = N\ sec.^3\ \phi.$$

$$T' = \frac{N'}{cos.^3\ \alpha} = N'\ sec.^3\ \alpha.$$

Cases V, VI, VII and VIII

Angle of axes = 90 degrees (Fig. 4)

Cases V and VI. (Preliminary Solution)

Given

C = Center distance of axes (Case V approx) (Case VI fixed).

D and D' = Approximate pitch diameters of gears.

R = Speed ratio $= \frac{N}{N'}$.

P = Diametral pitch of cutters.

Solve for trial value of ϕ

$$Tan.\ \phi = \frac{D}{RD'} \text{ or, } cot.\ \phi = \frac{RD'}{D}.$$

Solve for N and N'

$$N = DP\ cos.\ \phi. \quad N' = (D'P\ sin.\ \phi) = \frac{N}{R}.$$

Take the nearest whole values of N and N' which will give the desired value of R.

Cases VII and VIII. (Preliminary Solution)

Given

ϕ and α = Tooth helix angles (Case VII fixed) (Case VIII approx.).

C = Center distance of axes (Case VII approx) (Case VIII fixed).

R = Speed ratio $= \frac{N}{N'}$.

P = Diametral pitch of cutters.

Solve for N and N'

$$N = \frac{2CP}{sec.\ \phi + \frac{cosec.\ \phi}{R}}$$

or

$$N = \frac{2CPR}{R\ sec.\ \phi + cosec.\ \phi}.$$

$$N' = \left(\frac{2CP}{R\ sec.\ \phi + cosec.\ \phi}\right) = \frac{N}{R}.$$

Take the nearest whole values of N and N' which will give the desired value of R.

Case V (Continued)

Take any selected angle approximately equal to the value of ϕ obtained in the preliminary solution and solve for α.

$\alpha = 90$ degrees $- \phi$

Cases VI and VIII (Continued)

Solve by trial for the correct value of ϕ

$$sec.\ \phi + \frac{cosec.\ \phi}{R} = \frac{2CP}{N},$$

$$R\ sec.\ \phi + cosec.\ \phi = \frac{2CP}{N'},$$

$$N\ sec.\ \phi + N'\ cosec.\ \phi = 2CP.$$

Note—If R is less than $\frac{1}{4}$ and a simple ratio like $\frac{2}{3}$ or $\frac{1}{2}$, the best formula to use is $\left(sec.\ \phi + \frac{cosec.\ \phi}{R}\right)$. If R is greater than $\frac{1}{4}$ and a simple ratio like $\frac{3}{4}$ or $\frac{1}{4}$, the best formula to use is $(R\ sec.\ \phi + cosec.\ \phi)$. If R is a more complex ratio like $\frac{7}{8}$ or $\frac{15}{16}$, the best formula to use is $(N\ sec.\ \phi + N'\ cosec.\ \phi)$.

Solve for α

$\alpha = 90$ degrees $- \phi$

Case VII (Continued)

Take the fixed values of ϕ and α as given in the preliminary solution.

Cases V, VI, VII and VIII (Final Solution)

Solve for D and D'

$$D = \frac{N}{P}\ sec.\ \phi. \qquad D' = \frac{N'}{P}\ cosec.\ \phi.$$

Solve for C

$$C = \frac{D + D'}{2}.$$

Note—In Cases VI and VIII, this should exactly equal the value of C as given in the preliminary solution, and any discrepancy shows an error in the work.

Solve for $O\,D$ and $O\,D'$

$$O\,D = D + \frac{2}{P}. \qquad O\,D' = D' + \frac{2}{P}.$$

Solve for L and L'

$$L = \pi D\ cot.\ \phi = \frac{\pi N}{P}\ cosec.\ \phi.$$

$$L' = \pi D'\ tan.\ \phi = \frac{\pi N'}{P}\ sec.\ \phi.$$

Solve for T and T'

$$T = \frac{N}{cos.^3\ \phi} = N\ sec.^3\ \phi.$$

$$T' = \frac{N'}{sin.^3\ \phi} = N'\ cosec.^3\ \phi.$$

Case VII Special

Given

ϕ = Tooth helix angle = 45 degrees.

C = Center distance of axes (approx).

R = Speed ratio $= \frac{N}{N'}$.

P = Diametral pitch of cutters.

Solve for N and N'

$$N = \frac{1.4142\ CP}{1 + \frac{1}{R}} \text{ or } N = \frac{1.4142\ CPR}{R + 1}.$$

$$N' = \left(\frac{1.4142\ CP}{R + 1}\right) = \frac{N}{R}.$$

Take the nearest whole values of N and N' which will give the desired value of R.

Solve for D and D'

$$D = \frac{1.4142\ N}{P}. \qquad D' = \left(\frac{1.4142\ N'}{P}\right) = \frac{D}{R}.$$

Solve for C

$$C = \frac{D + D'}{2}.$$

Solve for $O\,D$ and $O\,D'$

$$OD = D + \frac{2}{P}. \qquad OD' = D' + \frac{2}{P}.$$

Solve for L and L'

$$L = \frac{4.4428\ N}{P}. \qquad L' = \left(\frac{4.4428\ N'}{P}\right) = \frac{L}{R}.$$

Solve for T and T'

$$T = 2.8283\ N. \qquad T' = (2.8283\ N') = \frac{T}{R}.$$

Cases IX and X. (Preliminary Solution)

Angle of axis $= O°$ (Fig. 5).

Given:

ϕ = tooth helix angle (Case IX fixed) (Case X approx.).

C = Center distance of axes (Case IX approx.) (Case X fixed).

R = Speed ratio $= \frac{N}{N'}$.

P = Diametral pitch of cutters.

Solve for N and N'

$$N = \frac{2\,C\,P\cos.\,\phi}{1 + \frac{1}{R}} \text{ or } N = \frac{2\,C\,P\,R\cos.\,\phi}{R + 1}.$$

$$N' = \left(\frac{2\,C\,P\cos.\,\phi}{R + 1}\right) = \frac{N}{R}.$$

Take the nearest whole values of N and N' which will give the desired value of R.

Case IX (Continued).

Take the fixed value of ϕ as given in the preliminary solution.

Case X. (Continued).

Solve for ϕ.

$$sec.\,\phi \quad \frac{2\,C\,P}{N + N'}.$$

Cases IX and X. (Final Solution)

Solve for D and D'

$$D = \frac{N}{P}\,sec.\,\phi. \qquad D' = \left(\frac{N}{P}\,sec.\,\phi\right) = \frac{D}{R}.$$

Solve for C.

$$C = \frac{D + D'}{2}.$$

Note—In Case X, this should exactly equal the value of C as given in the preliminary solution and any discrepancy shows an error in the work.

Solve for $O\,D$ and $O\,D'$

$$OD \quad D + \frac{2}{P}. \qquad OD' = D' + \frac{2}{P}.$$

Solve for L and L'

$$L = \pi D\,cot.\,\phi = \frac{\pi N}{P}\,cosec.\,\phi.$$

$$L' = (\pi D\,cot.\,\phi) = \left(\frac{\pi N}{P}\,cosec.\,\phi\right) = \frac{L}{R}.$$

Solve for T and T'.

$$T = \frac{N}{cos.^2\,\phi} = N\,sec.^2\,\phi.$$

$$T' = \left(\frac{N'}{cos.^2\,\phi}\right) = (N'\,sec.^2\,\phi) = \frac{T}{R}.$$

First Example. Cases I and II.

Given: $B = 40°$; $C = 4''$; $D = 3''$; $D' = 5''$; $R = \frac{1}{2}$; and $P = 12$.

$$Tan.\,\phi = \left(\frac{D}{D'R}\,cosec.\,B - cot.\,B\right) =$$

$$\left(\frac{3}{5 \times \frac{1}{2}}\,cosec.\,40° - cot.\,40°\right) = 0.67514.$$

$\phi = 34°\ 1'$. These conditions are as shown in Fig. 1.

$\alpha = B - \phi = 40° - 34°\ 1' = 5°\ 59'$.

$N = D\,P\cos.\,\phi = 3 \times 12 \times \text{cos. } 34°\ 1' = 29.84$.

$$N' \quad \frac{N}{R} = \frac{29.84}{\frac{1}{2}} = 59.68.$$

Take N as 30 and N' as 60.

Case I.

Take ϕ as 34°.

$\alpha = B - \phi = 40° - 34° = 6°$.

$$D \quad \frac{N}{P}\,sec.\,\phi \quad \frac{30}{12}\,sec.\,34° = 3.0155.$$

$$D' = \frac{N'}{P}\,sec.\,\alpha = \frac{60}{12}\,sec.\,6° = 5.0275.$$

$$C = \frac{D + D'}{2} = \frac{3.0155 + 5.0275}{2} = 4.0215.$$

$$OD = D + \frac{2}{P} = 3.0155 + \frac{2}{12} = 3.1822.$$

$$OD' = D' + \frac{2}{P} = 5.0275 + \frac{2}{12} = 5.1942.$$

$$L = \frac{\pi N}{P}\,cosec.\,\phi = \frac{3.1416 \times 30}{12}\,cosec.\,34°$$

$$= 14.045.$$

$$L' = \frac{\pi N'}{P}\,cosec.\,\alpha = \frac{3.1416 \times 60}{12}\,cosec.\,6°$$

$$= 150.28.$$

$T = N\,sec.^2\,\phi = 30\,sec.^2\,34° = 52.65$.

$T' = N'\,sec.^2\,\alpha = 60\,sec.^2\,6° = 61$.

Case II.

$$\left(Sec.\,\phi + \frac{sec.\,\alpha}{R} = \frac{2\,C\,P}{N}\right) =$$

$$\left(sec.\,\phi + \frac{sec.\,\alpha}{\frac{1}{2}} = \frac{2 \times 4 \times 12}{30}\right) =$$

$$(sec.\,\phi + 2\,sec.\,\alpha = 3.2).$$

Assume $\phi = 34°\ 0'$ and $\alpha = 6°\ 0'$, $1.2062 + 2(1.0055) = 3.2172$.

Assume $\phi = 33°\ 0'$ and $\alpha = 7°\ 0'$, $1.1924 + 2(1.0075) = 3.2074$.

Assume $\phi = 32°\ 0'$ and $\alpha = 8°\ 0'$, $1.1792 + 2(1.0098) = 3.1988$.

The value of ϕ must lie between 32° 0' and 33° 0'.

By making a proportion of these results and reducing to minutes, we have

$$\frac{3.2 - 3.1988}{3.2074 - 3.1988} \times 60 = \frac{0.0012}{0.0086} \times 60 = 8.4.$$

Assume $\phi = 32°\ 8'$ and $\alpha = 7°\ 52'$, $1.1809 + 2(1.0095) = 3.1999$.

Assume $\phi = 32°\ 9'$ and $\alpha = 7°\ 51'$, $1.1811 + 2(1.0094) = 3.1999$.

Assume $\phi = 32°\ 10'$ and $\alpha = 7°\ 50'$, $1.1813 + 2(1.0094) = 3.2001$.

As may readily be seen, ϕ must be midway between 32° 9' and 32° 10'.

Assume $\phi = 32°\ 9.5'$ and $\alpha = 7°\ 50.5'$, $1.1812 + 2(1.0094) = 3.2$.

Therefore $\phi = 32°\ 9.5'$ and $\alpha = 7°\ 50.5'$.

$$D = \frac{N}{P}\,sec.\,\phi = \frac{30}{12}\,sec.\,32°\ 9.5' = 2.9530.$$

$$D' = \frac{N'}{P}\,sec.\,\alpha = \frac{60}{12}\,sec.\,7°\ 50.5' = 5.0470.$$

$$C = \frac{D + D'}{2} = \frac{2.9530 + 5.0470}{2} = 4.$$

$$O\,D = D + \frac{2}{P} = 2.9530 + \tfrac{2}{12} = 3.1197.$$

$$O\,D' = D' + \frac{2}{P} = 5.0470 + \tfrac{2}{12} = 5.2137.$$

$$L = \frac{\pi N}{P}\,cosec.\,\phi =$$

$$\frac{3.1416 \times 30}{12}\,cosec.\,32°\ 9.5' = 14.756.$$

$$L' = \frac{\pi N'}{P}\,cosec.\,\alpha =$$

$$\frac{3.1416 \times 60}{12}\,cosec.\,7°\ 50.5' = 115.13.$$

$T = N\,sec.^2\,\phi = 30\,sec.^2\,32°\ 9.5' = 49.44$

$T' = N'\,sec.^2\,\alpha = 60\,sec.^2\,7°\ 50.5' = 61.71$.

Second Example. Cases I and II

Given

$B = 15°$, $C = 4$, $D = 3$, $D' = 5$, $R = \frac{1}{2}$ and $P = 12$.

$$Tan.\,\phi = \left(\frac{D}{D'R}\,cosec.\,B - cot.\,B\right) =$$

$$\left(\frac{3}{5 \times \frac{1}{2}}\,cosec.\,15° - cot.\,15°\right) = 0.90444.$$

$\phi = 42°\ 8'$. These conditions are as as shown in Fig. 2.

$\alpha = \phi - B = 42°\ 8' - 15° = 27°\ 8'$.

$N = D\,P\,cos.\,\phi = 3 \times 12 \times cos.\ 42°\ 8' = 26.7$.

$$N' = \frac{N}{R} = \frac{26.7}{\frac{1}{2}} = 53.4.$$

Take N as 27 and N' as 54. Proceed as in first example for the remainder of solution and it will be found that for Case II,

$\phi = 41°\ 8'$	$\alpha = 26°\ 8'$
$D = 2.9874$	$D' = 5.0126$
$C = 4$	
$O\,D = 3.154$	$O\,D' = 5.1793$
$L = 10.746$	$L' = 32.096$
$T = 63.19$	$T' = 74.62$

Third Example. Cases I and II.

Given

$B = 25°$, $C = 4$, $D = 2$, $D' = 6$, $R = \frac{1}{2}$ and $P = 12$.

$$Tan.\,\phi = \left(\frac{D}{D'R}\,cosec.\,B - cot.\,B\right) =$$

$$\left(\frac{2}{6 \times \frac{1}{2}}\,cosec.\,25° - cot.\,25°\right) = -0.5670.$$

$\phi = 29°\ 33'$. These conditions are as shown in Fig. 3.

$\alpha = \phi + B = 29°\ 33' + 25° = 54°\ 33'$.

$N = D\,P\,cos.\,\phi = 2 \times 12 \times \text{cos. } 29°\ 33' = 20.9$.

$$N' = \frac{N}{R} = \frac{20.9}{\frac{1}{2}} = 41.8.$$

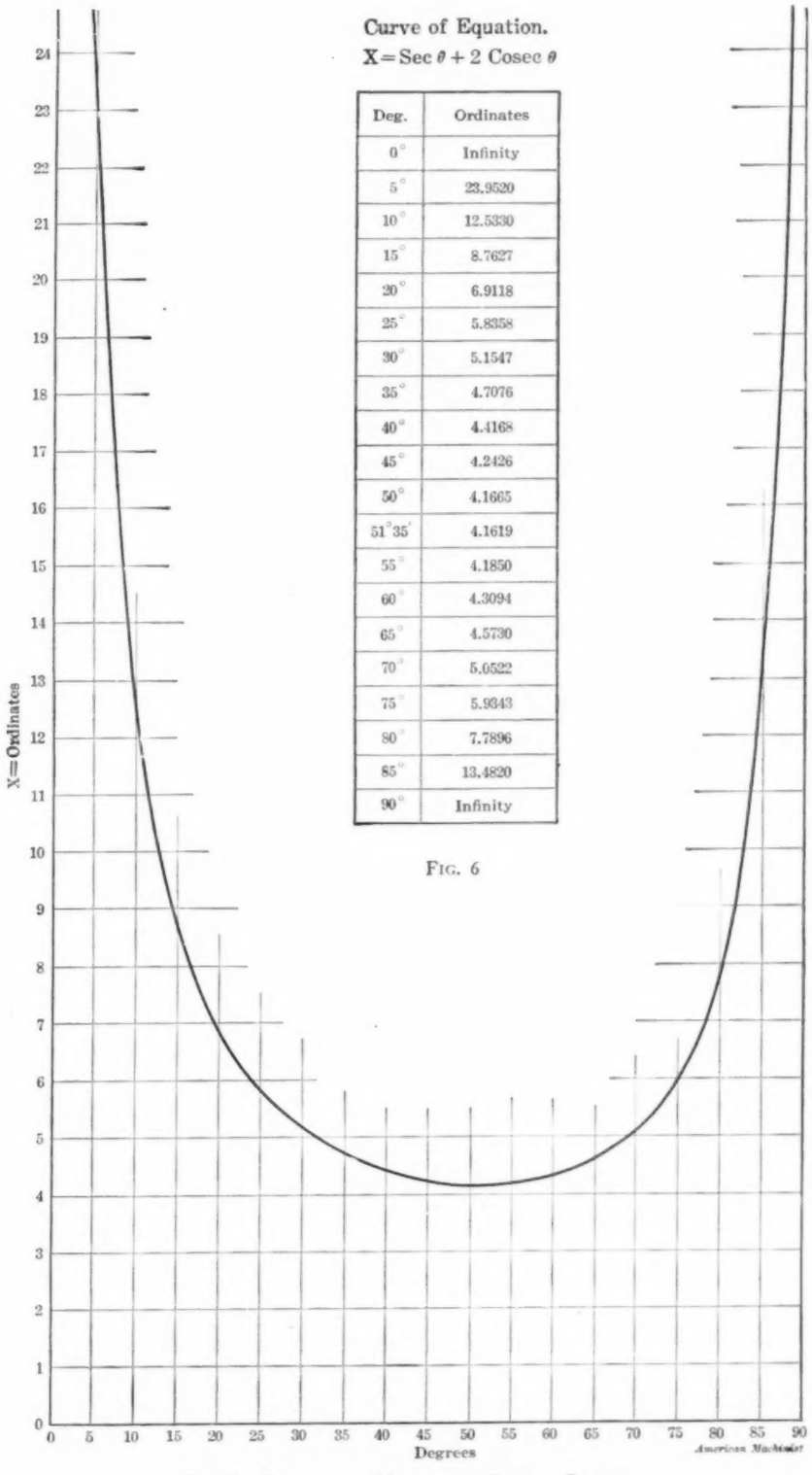
Take N as 21 and N' as 42. Proceed as in first example for the remainder of solution and it will be found that for Case II,

$\phi = 29°\ 16.3'$ $\alpha = 54°\ 16.3'$
$D = 2.0063$ $D' = 5.9937$
$C = 4$

$O\,D = 2.1730$ $O\,D' = 6.1604$
$L = 11.244$ $L' = 13.545$
$T = 31.64$ $T' = 210.9$

Example. Cases III and IV.

In these two cases, as the values of ϕ and α are given, it will be known at once, whether the conditions apply to Figs. 1, 2 or 3.
Given



Deg.	Ordinates
0°	Infinity
5°	23.9520
10°	12.5330
15°	8.7627
20°	6.9118
25°	5.8358
30°	5.1547
35°	4.7076
40°	4.4168
45°	4.2426
50°	4.1665
51°35'	4.1619
55°	4.1850
60°	4.3094
65°	4.5730
70°	5.0522
75°	5.9343
80°	7.7896
85°	13.4820
90°	Infinity

FIG. 6

FIG. 6. CURVE AND VALUES OF SPIRAL GEARS

$B = 60°$, $\phi = 45°$, $\alpha = 15°$, $C = 4$, $R = \frac{1}{2}$ and $P = 12$.

These conditions are as shown in Fig. 1.

$$N = \frac{2\,C\,P}{sec.\,\phi + \frac{sec.\,\alpha}{R}} = \frac{2 \times 4 \times 12}{sec.\,45° + \frac{sec.\,15°}{\frac{1}{2}}} = 27.6$$

$$N' = \frac{N}{R} = \frac{27.6}{\frac{1}{2}} = 55.2.$$

Take N as 28 and N' as 56.

Case III

$$D = \frac{N}{P}\,sec.\,\phi = \frac{28}{12}\,sec.\,45° = 3.2998.$$

$$D' = \frac{N'}{P}\,sec.\,\alpha = \frac{56}{12}\,sec.\,15° = 4.8314.$$

$$C = \frac{D + D'}{2} = \frac{3.2998 + 4.8314}{2} = 4.0656.$$

The remainder of the solution is as follows:

$O\,D = 3.4665$ $O\,D' = 4.9981$
$L = 10.364$ $L' = 56.645$
$T = 79.19$ $T' = 62.14$

Case IV

$$\left(sec.\,\phi + \frac{sec.\,\alpha}{R} = \frac{2\,C\,P}{N}\right) =$$

$$\left(sec.\,\phi + \frac{sec.\,\alpha}{\frac{1}{2}} = \frac{2 \times 4 \times 12}{28}\right) =$$

$$(sec.\,\phi + 2\,sec.\,\alpha = 3.4286).$$

Solving for ϕ and α as shown in first example of Case II, we obtain $\phi = 38°\ 55'$ and $\alpha = 21°\ 5'$.

$$D = \frac{N}{P}\,sec.\,\phi = \frac{28}{12}\,sec.\,38°\ 55' = 2.9988.$$

$$D' = \frac{N'}{P}\,sec.\,\alpha = \frac{56}{12}\,sec.\,21°\ 5' = 5.0012.$$

$$C = \frac{D + D'}{2} = \frac{2.9988 + 5.0012}{2} = 4.$$

The remainder of the solution is as follows:

$O\,D = 3.1655$ $O\,D' = 5.1679$
$L = 11.669$ $L' = 40.756$
$T = 59.45$ $T' = 68.94$

Example. Cases V and VI

Given

$C = 5$, $D = 4$, $D' = 6$, $R = \frac{1}{3}$ and $P = 12$.

$$Tan.\,\phi = \frac{D}{R\,D} = \frac{4}{\frac{1}{3} \times 6} = 2.$$

$\phi = 63°\ 26'$.

$N = D\,P\,cos.\,\phi = 4 \times 12 \times cos.\,63°\ 26' = 21.47.$

$$N' = \frac{N}{R} = \frac{21.47}{\frac{1}{3}} = 64.41.$$

Take N as 21 and N' as 63.

Case V

Take ϕ as 63°.

$\alpha = 90° - \phi = 90° - 63° = 27°.$

$$D = \frac{N}{P}\,sec.\,\phi = \frac{21}{12}\,sec.\,63° = 3.8547.$$

$$D' = \frac{N'}{P}\,cosec.\,\phi = \frac{63}{12}\,cosec.\,63° = 5.8921.$$

$$C' = \frac{D + D'}{2} = \frac{3.8547 + 5.8921}{2} = 4.8734.$$

$$O\,D = D + \frac{2}{P} = 3.8547 + \tfrac{2}{12} = 4.0214.$$

$$O\,D' = D' + \frac{2}{P} = 5.8921 + \tfrac{2}{12} = 6.0588.$$

$$L = \frac{\pi N}{P}\ cosec.\ \phi =$$

$$\frac{3.1416 \times 21}{12}\ cosec.\ 63^\circ = 6.1706.$$

$$L' = \frac{\pi N'}{P}\ sec.\ \phi =$$

$$\frac{3.1416 \times 63}{12}\ sec.\ 63^\circ = 36.329.$$

$T = N\ sec.^3\ \phi = 21\ sec.^3\ 63^\circ = 224.4.$

$T' = N'\ cosec.^3\ \phi = 63\ cosec.^3\ 63^\circ = 89.06.$

Case VI

$$\left(sec.\ \phi + \frac{cosec.\ \phi}{R} = \frac{2CP}{N}\right) =$$

$$\left(sec.\ \phi + \frac{cosec.\ \phi}{\frac{1}{3}} = \frac{2 \times 5 \times 12}{21}\right) =$$

$$(sec.\ \phi + 3\ cosec.\ \phi = 5.7143).$$

Assume

$\phi = 64^\circ$, $2.2812 + 3\,(1.1126) = 5.6190$

$\phi = 65^\circ$, $2.3662 + 3\,(1.1034) = 5.6764$

$\phi = 66^\circ$, $2.4586 + 3\,(1.0946) = 5.7424$

The value of ϕ must be between 65° and 66°.

By making a proportion of these results and reducing to minutes we have,

$$\frac{5.7143 - 5.6764}{5.7424 - 5.6764} \times 60 = \frac{0.0379}{0.0660} \times 60 = 34.4.$$

Assume

$\phi = 65^\circ\ 34'$, $2.4176 + 3\,(1.0984) = 5.7128.$

$\phi = 65^\circ\ 35'$, $2.4191 + 3\,(1.0982) = 5.7137.$

$\phi = 65^\circ\ 36'$, $2.4207 + 3\,(1.0981) = 5.7150.$

The Value of ϕ must be between 65° 35′ and 65° 36′. By making a proportion of these results we have,

$$\frac{5.7143 - 5.7137}{5.7150 - 5.7137} = \frac{0.0006}{0.0013} = 0.462,$$

therefore we may assume that

$$\phi = 65^\circ\ 35.5',\ 2.4199 + 3\,(1.09815) = 5.7143.$$

Therefore,

$$\phi = 65^\circ\ 35.5'.$$

$$\alpha = 90^\circ - \phi = 90^\circ - 65^\circ\ 35.5' = 24^\circ\ 24.5'.$$

$$D = \frac{N}{P}\ sec.\ \phi = \tfrac{21}{12}\ sec.\ 65^\circ\ 35.5' = 4.2348.$$

$$D' = \frac{N'}{P}\ cosec.\ \phi = \tfrac{63}{12}\ cosec.\ 65^\circ\ 35.5' = 5.7652$$

$$C = \frac{D + D'}{2} = \frac{4.2348 + 5.7652}{2} = 5.$$

$$O\,D = D + \frac{2}{P} = 4.2348 + \tfrac{2}{12} = 4.4015.$$

$$O\,D' = D' + \frac{2}{P} = 5.7652 + \tfrac{2}{12} = 5.9319.$$

$$L = \frac{\pi N}{P}\ cosec.\ \phi =$$

$$\frac{3.1416 \times 21}{12}\ cosec.\ 65^\circ\ 35.5' = 6.0374.$$

$$L' = \frac{\pi N'}{P}\ sec.\ \phi =$$

$$\frac{3.1416 \times 63}{12}\ sec.\ 65^\circ\ 35.5' = 39.913.$$

$T = N\ sec.^3\ \phi = 21\ sec.^3\ 65^\circ\ 35.5' = 297.6.$

$T' = N'\ cosec.^3\ \phi = 63\ cosec.^3\ 65^\circ\ 35.5' = 83.43.$

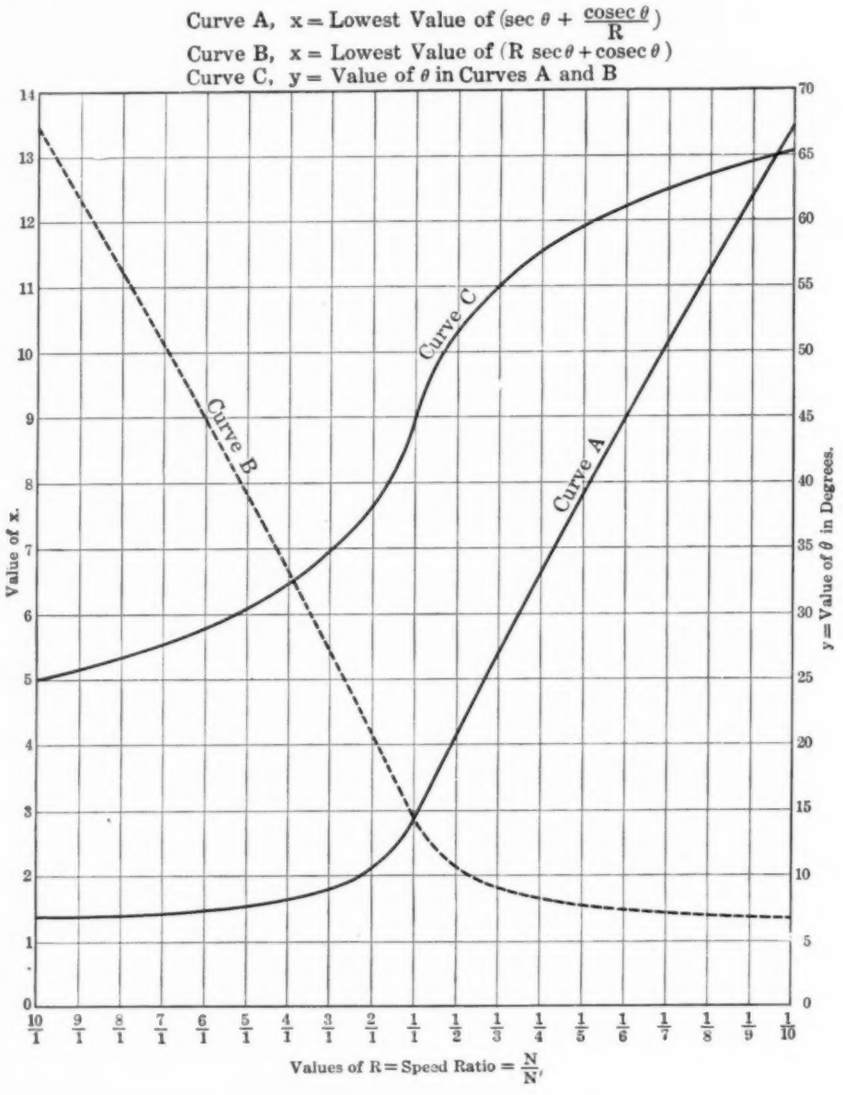
Example. Cases VII and VIII

Given $\phi = 30^\circ$, $\alpha = 60^\circ$, $C = 3.5$, $R = 2$ and $P = 12$.

$$N = \frac{2CPR}{R\ sec.\ \phi + cosec.\ \phi} =$$

$$\frac{2 \times 3.5 \times 12 \times 2}{2\ sec.\ 30^\circ + cosec.\ 30^\circ} = 38.9.$$

$$N' = \frac{N}{R} = \frac{38.9}{2} = 19.45.$$


Curve A, x = Lowest Value of (sec θ + cosec θ / R)
Curve B, x = Lowest Value of (R sec θ + cosec θ)
Curve C, y = Value of θ in Curves A and B
Curve A
Curve B
Curve C
Value of x.
y = Value of θ in Degrees.
Values of R = Speed Ratio = N/N'

R	C	Values of Curves. A	B
10/1	24° 51′	1.3400	13.3996
9/1	25° 45′	1.3660	12.2936
8/1	26° 42′	1.3975	11.1800
7/1	27° 45′	1.4367	10.0570
6/1	28° 54′	1.4871	8.9224
5/1	30° 13′	1.5546	7.7730
4/1	32° 16′	1.6509	6.6035
3/1	34° 53′	1.8018	5.4055
2/1	38° 25′	2.0610	4.1619
3/2	41° 5′	2.3411	3.5117
1/1	45°	2.8284	2.8284
2/3	48° 55′	3.5117	2.3411
1/2	51° 35′	4.1619	2.0610
1/3	55° 7′	5.4055	1.8018
1/4	57° 44′	6.6035	1.6509
1/5	59° 47′	7.7730	1.5546
1/6	61° 6′	8.9224	1.4871
1/7	62° 15′	10.0570	1.4367
1/8	63° 18′	11.1800	1.3975
1/9	64° 15′	12.2936	1.3660
1/10	65° 9′	13.3996	1.3400

American Machinist

FIG. 7. CURVES AND VALUES OF SPIRAL GEARS

Take N as 38 and N′ as 19.

Case VII

$$D = \frac{N}{P} \text{ sec. } \phi = \tfrac{38}{12} \text{ sec. } 30° = 3.6566.$$

$$D' = \frac{N'}{P} \text{ cosec. } \phi = \tfrac{19}{12} \text{ cosec. } 30° = 3.1667.$$

$$C = \frac{D + D'}{2} = \frac{3.6566 + 3.1667}{2} = 3.4116$$

The remainder of the solution is as follows:

$O\,D = 3.8233$	$O\,D' = 3.3334$
$L = 19.897$	$L' = 5.7437$
$T = 58.5$	$T' = 152.0$

Case VIII.

$$\left(R \text{ sec. } \phi + \text{cosec. } \phi = \frac{2\,CP}{N}\right) =$$

$$\left(2 \text{ sec. } \phi + \text{cosec. } \phi = \frac{2 \times 3.5 \times 12}{19}\right) =$$

$$(2 \text{ sec. } \phi + \text{cosec. } \phi = 4.4211).$$

Solving for ϕ as shown in example for Case VI we obtain,

$\phi = 27°\ 29.3'$.

$\alpha = 90° - \phi = 90° - 27°\ \ 29.3' = 62°\ 30.7'$.

$$D = \frac{N}{P} \text{ sec. } \phi = \tfrac{38}{12} \text{ sec. } 27°\ 29.3' = 3.5697.$$

$$D' = \frac{N'}{P} \text{ cosec. } \phi = \tfrac{19}{12} \text{ cosec. } 27°\ 29.3' = 3.4303.$$

$$C = \frac{D + D'}{2} = \frac{3.5697 + 3.4303}{2} = 3.5.$$

The remainder of the solution is as follows:

$O\,D = 3.7364$	$O\,D' = 3.5970$
$L = 21.553$	$L' = 5.6073$
$T = 54.43$	$T' = 193.2$

Special Example. $\phi = 45°$. Case VII.

Given $\phi = 45°\ 0'$; $\alpha = 45°\ 0'$; $C = 3.5$; $R = \frac{1}{2}$; and $P = 12$.

$$N = \frac{1.4142\,CP}{1 + \frac{1}{R}} = \frac{1.4142 \times 3.5 \times 12}{1 + \frac{1}{\frac{1}{2}}} = 19.8$$

$$N' = \frac{N}{R} = \frac{19.8}{\frac{1}{2}} = 39.6.$$

Take N as 20 and N' as 40.

$$D = \frac{1.4142\,N}{P} = \frac{1.4142 \times 20}{12} = 2.357.$$

$$D' = \frac{D}{R} = \frac{2.357}{\frac{1}{2}} = 4.714.$$

$$C = \frac{D + D'}{2} = \frac{2.357 + 4.714}{2} = 3.5355.$$

$$O\,D = D + \frac{2}{P} = 2.357 + \tfrac{2}{12} = 2.5237.$$

$$O\,D' = D' + \frac{2}{P} = 4.714 + \tfrac{2}{12} = 4.8807.$$

$$L = \frac{4.4428\,N}{P} = \frac{4.4428 \times 20}{12} = 7.4047.$$

$$L' = \frac{L}{R} = \frac{7.4047}{\frac{1}{2}} = 14.8094.$$

$$T = 2.8283\,N = 2.8283 \times 20 = 56.566.$$

$$T' = \frac{T}{R} = \frac{56.566}{\frac{1}{2}} = 113.132.$$

Example. Cases IX and X.

Given

$\phi = 25°$; $C = 5.5$; $R = \frac{3}{5} = 0.6$; and $P = 12$.

$$N = \frac{2\,CPR}{R + 1} = \frac{2 \times 5.5 \times 12 \times 0.6}{0.6 + 1} = 44.5.$$

$$N' = \frac{N}{R} = \frac{44.5}{0.6} = 74.2.$$

Take N as 45 and N' as 75.

Case IX.

$$D = \frac{N}{P} \text{ sec. } \phi = \tfrac{45}{12} \text{ sec. } 25° = 4.1378.$$

$$D' = \frac{D}{R} = \frac{4.1378}{0.6} = 6.8963.$$

$$C = \frac{D + D'}{2} = \frac{4.1378 + 6.8963}{2} = 5.5171.$$

$$O\,D = D + \frac{2}{P} = 4.1378 + \tfrac{2}{12} = 4.3045.$$

$$O\,D' = D' + \frac{2}{P} = 6.8963 + \tfrac{2}{12} = 7.0630.$$

$$L = \frac{\pi N}{P} \text{ cosec. } \phi =$$

$$\frac{3.1416 \times 45}{12} \text{ cosec. } 25° = 27.876.$$

$$L' = \frac{L}{R} = \frac{27.876}{0.6} = 46.46.$$

$$T = N \text{ sec.}^2\ \phi = 45 \text{ sec.}^2\ 25° = 60.45.$$

$$T' = \frac{T}{R} = \frac{60.45}{0.6} = 100.75.$$

Case X.

$$\text{Sec. } \phi = \frac{2\,CP}{N + N'} = \frac{2 \times 5.5 \times 12}{45 + 75} = 1.1.$$

$\phi = 24°\ 37'$.

$$D = \frac{N}{P} \text{ sec. } \phi = \tfrac{45}{12} \text{ sec. } 24°\ 37' = 4.125.$$

$$D' = \frac{D}{R} = \frac{4.125}{0.6} = 6.875.$$

$$C = \frac{D + D'}{2} = \frac{4.125 + 6.875}{2} = 5.5.$$

$$O\,D = D + \frac{2}{P} = 4.125 + \tfrac{2}{12} = 4.2917.$$

$$O\,D' = D' + \frac{2}{P} = 6.875 + \tfrac{2}{12} = 7.0417.$$

$$L = \frac{\pi N}{P} \text{ cosec. } \phi =$$

$$\frac{3.1416 \times 45}{12} \text{ cosec. } 24°\ 37' = 28.283.$$

$$L' = \frac{L}{R} = \frac{28.283}{0.6} = 47.138.$$

$$T = N \text{ sec.}^2\ \phi = 45 \text{ sec.}^2\ 24°\ 37' = 59.89.$$

$$T' = \frac{T}{R} = \frac{59.89}{0.6} = 99.82.$$

Curves of $\left(\text{sec. } \phi + \frac{\text{cosec. } \phi}{R}\right)$ and (R sec. ϕ + cosec. ϕ) and their application to Cases VI and VIII.

In Fig. 6 is shown the curve of the values of $\left(\text{sec. } \phi + \frac{\text{cosec. } \phi}{R}\right)$ when R is taken as $\frac{1}{2}$, thus making the equation x = sec. ϕ + 2 cosec. ϕ. The lowest point of this curve occurs at 51° 35′, and its value is 4.1619. As sec. ϕ = cosec. (90° − ϕ), it is evident that Fig. 6 will be the curve of (2 sec. ϕ + cosec. ϕ) or (R sec. ϕ + cosec. ϕ) when R = 2, if the values of ϕ are taken as their complements. For instance, the value of (sec. ϕ + 2 cosec. ϕ) in the curve of Fig. 6 for 70° 0′ is 5.0522. This would be the value of (2 sec. ϕ + cosec. ϕ) for 90° 0′ − 70° 0′ or 20° 0′. Curves similar to Fig. 6 may be plotted for either $\left(\text{sec. } \phi + \frac{\text{cosec. } \phi}{R}\right)$ or (R sec. ϕ + cosec. ϕ). They all will show the same characteristics as Fig. 6, but the angle at which the lowest value occurs and the lowest value itself will vary with the different values of R.

In Fig. 7 are shown the curves of the lowest values of both $\left(\text{sec. } \phi + \frac{\text{cosec. } \phi}{R}\right)$ and (R sec. ϕ + cosec. ϕ), and their corresponding angles for values of R ranging from $\frac{1}{1}^0$ to $\frac{1}{15}$.

From the form of the curve in Fig. 6 it will be seen that the values of $\left(\text{sec. } \phi + \frac{\text{cosec. } \phi}{R}\right)$ and (R sec. ϕ + cosec. ϕ), for any value of R, decrease as the angle increases from 0° 0′ to the ϕ given in curve C of Fig. 7, and from this ϕ to 90° 0′, the values increase as the angle increases. In general terms this may be stated as follows: An increase in the value of ϕ increases the pitch diameter of the driver and decreases the pitch diameter of the follower. From 0° 0′ to the ϕ given in curve C of Fig. 7, the amount of increase of the driver is less than the amount of decrease of the follower, and therefore, the center distance decreases. From this ϕ to 90° 0′ the amount of increase of the driver is more than the amount of decrease of the follower, and therefore, the center distance increases.

The above facts are useful when solving for the correct value of ϕ in Cases VI and VIII. Referring back to the example in Case VI, it will be seen that the first trial value of ϕ was 64° 0′, which gave 5.6190 for the value of (sec. 64° 0′ + 3 cosec. 64° 0′). The value of (sec. ϕ + 3 cosec. ϕ) must equal 5.7143. Shall 63° 0′ or 65° 0′ be tried next? Now $R = \frac{1}{3}$ and by referring to curve C of Fig. 7, it will be found that for the lowest value of $\left(\text{sec. } \phi + \frac{\text{cosec. } \phi}{R}\right)$, the value of ϕ = 55° 7′. Therefore, as 64° 0′ is more than 55° 7′, it will be necessary to increase the angle in order to increase the value of (sec. ϕ + 3 cosec. ϕ), and hence the next trial value of ϕ must be taken as 65° 0′ instead of 63° 0′.

In order to show another use to which the curves of Fig. 6, (or similar curves with other values of R), and of Fig. 7, may be put, let us take another example in Case VI.

Given

$C = 5$, $D = 4$, $D' = 6$, $R = \frac{1}{2}$, and $P = 12$.

$$\text{Tan. } \phi = \frac{D}{D'R} = \frac{4}{6 \times \frac{1}{2}} = 1.3333.$$

$$\phi = 53°\ 8'.$$

$N = D P \cos. \phi = 4 \times 12 \times \cos. 53° 8' = 28.8.$

$$N' = \frac{N}{R} = \frac{28.8}{\frac{1}{2}} = 57.6.$$

Take N as 29 and N' as 58.

$$\left(\sec. \phi + \frac{\operatorname{cosec.} \phi}{R} = \frac{2 C P}{N}\right) =$$

$$\left(\sec. \phi + \frac{\operatorname{cosec.} \phi}{\frac{1}{2}} = \frac{2 \times 5 \times 12}{29}\right) =$$

$$(\sec. \phi + 2 \operatorname{cosec.} \phi = 4.1379).$$

This value of 4.1379 is less than the lowest value of $\left(\sec. \phi + \frac{\operatorname{cosec.} \phi}{R}\right)$ in Figs. 6 and 7, which is 4.1619 with an angle of 51° 35′ when the value of R is ½. Therefore, the example is an impossible case, using gears of 29 teeth and 58 teeth. The fractional teeth 28.8 and 57.6 (see above) would solve the example with an angle of 53° 8′, but fractional teeth are, of course, an impossibility. Therefore, we will have to take N as 28 and N' as 56.

$$\left(\sec. \phi + \frac{\operatorname{cosec.} \phi}{R} = \frac{2 C P}{N}\right) =$$

$$\left(\sec. \phi + \frac{\operatorname{cosec.} \phi}{\frac{1}{2}} = \frac{2 \times 5 \times 12}{28}\right) =$$

$$(\sec. \phi + 2 \operatorname{cosec.} \phi = 4.2857).$$

By again referring to Fig. 6, it will be found that two selections of ϕ may be made, one lying between 40° 0′ and 45° 0′, and the other at approximately 60° 0′. By actual solution two results are obtained as follows:

$\phi = 43° 26.7'$	$\phi = 59° 19.8'$
$\alpha = 46° 33.3'$	$\alpha = 30° 40.2'$
$D = 3.2137$	$D = 4.5743$
$D' = 6.7863$	$D' = 5.4257$
$C = 5$	$C = 5$

The above leads to this general statement: Given the fixed center distance between axes, the diametrical pitch and the numbers of teeth for a pair of spiral gears with axes at right angles, there is no solution if the value of $\frac{2 C P}{N}$ is less than the curve A of Fig. 7, or if the value of $\frac{2 C P}{N'}$ is less than the curve B. If the values are just equal to the curves, there is but one solution in which case the angle is equal to ϕ in curve C. If the values are greater than the curves, there are two solutions in which case one angle is less and the other greater than the ϕ in curve C.

Accurate curves, similar to Fig. 6, but plotted for the different values of R could be employed in Cases VI and VIII for determining very closely the correct value of ϕ, and then if a closer result was desired, the final solution could be obtained through the use of the formulae.

Increasing Output Without Enlarging

By John R. Godfrey

We have recently found two very interesting examples of the substantial increasing of the output of a shop by rearranging the machines and concentrating the work instead of enlarging the plant, as is often considered the only way possible to increase production.

The Cleveland Automatic Machine Company had in contemplation the erection of a large addition to its shops previous to the depression of 1907. Plans were made, but after careful consideration on the part of Mr. Brophy and others, it was decided to defer building and to see what could be done in rearranging the plant to secure greater concentration of effort and increased output all along the line.

This, of course, required time and careful study, but as department after department was critically examined it became evident that considerable improvement could be made in the way of concentrating machines, eliminating waste space, and increasing the efficiency of both the men and the machines. The various changes, for many machines were moved during the process of concentration, cost about $2000, but the expenditure was slight in comparison with the results obtained. In this way, without enlarging the plant except to the extent of a comparatively small building for storage, the total output has been increased 30 per cent.

One of the interesting features in the management of this shop is the extreme care which is taken to insure the duplication of parts. No money is spared in the making of jigs and fixtures, nor is this care confined to the mere making of these fixtures and tools. They are constantly inspected to be sure that the size is maintained, which is a point too often overlooked.

It is too often the case that, after special fixtures and tools are made, it is assumed that they will take care of themselves and always maintain their original size. That this is not the case can be vouched for by those who have had endless trouble in assembling work where this practice prevails.

The other instance is that of the Goodman Manufacturing Company, Chicago, Ill., builders of mining machinery, whose output has been materially increased by the rearrangement of machine tools into departments, and the improved methods introduced by the works manager, F. G. Kent. He found a very complicated system, which included a volume of instructions for foremen, which was longer than the moral law and which no foremen ever pretended to remember and replaced it with one much more simple in every detail.

Machines are grouped according to the work to be done, power distribution is concentrated as much as possible, and a large number of antiquated tools have been replaced by those of modern design. This released several hundred dollars' worth of wooden split pulleys, which meant a decreased load on the line shaft and is only an indication of the saving introduced all along the line.

As an example, a 56-inch Cincinnati planer, equipped with a variable-speed countershaft, reduced the planing time on one particular job from 100 to 72 hours, and Mr. Kent has found an average saving of something over 10 per cent. wherever he has been able to introduce this device. The total output of the shop has been materially increased without expending a dollar for new buildings, and comparatively few machine tools have been installed.

Another innovation was the rearranging of the line shafting and the installing of Hyatt roller bearings, which has materially reduced the loss due to line-shaft friction. Individual motors have been installed on some of the larger machines, but group driving, and not particularly small groups is the general plan. In changing the line shaft, 1 15/16-inch shafting was used to replace the old, which was 2 3/16 inches in diameter. This was made possible by decreasing the load on the shafting and increasing its speed, which is a tendency in modern shops.

These two instances show concrete examples of the way in which many shops can increase their output at a minimum of expense and without increasing the overhead charges to any such extent as is necessary when new buildings are erected. This does not mean that new buildings are never necessary, or that it is unwise to think of enlarging a shop, but simply shows two cases where the increase desired has been secured in the least expensive way.

Exports of iron and steel manufactures in the last 15 years exceeded imports thereof by $1,400,000,000, while in the 15 years immediately preceding the imports of this class of merchandise exceeded exports by $300,000,000. Meantime, the United States has become by far the world's largest producer of pig iron advancing to 25,750,000 tons in 1909.

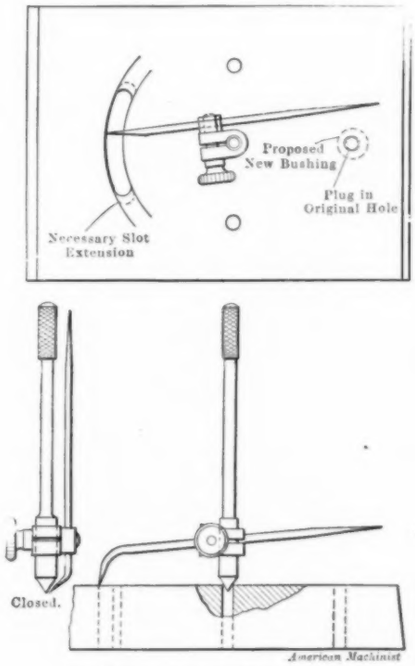
Letters from Practical Men

Concerning the details of making things in machine shops, from the first sketch to the shipping room.

A letter good enough to print is good enough to pay for. The value is in the idea—not the length of the letter.

Cone Center Divider

The toolmaker or machinist who occasionally "gets up against" the proposition of scribing accurate locating lines around existing holes or centers, may appreciate the little device illustrated in the accompanying sketches. It consists of the clamping sleeve and needle of a regular toolmakers' surface gage to which has been fitted a hardened center bar having a 60-degree cone center at the lower end, and turned smaller and nurled at the top. It is preferably made of drill rod the size of the surface gage bar, so that the clamping sleeve will fit on. If the holes to be used as centers are larger, it is, of course, necessary to have a correspondingly larger cone. In use, the needle should be set so that the bar will be quite vertical, as this gives the proper contact on the edge of the hole; the elevation shows this properly. The plan view shows the divider as applied to extension and relocation work on an annealed piercing die, while the sketch at the left shows how it may be folded up.



CONE CENTER DIVIDER

This device is not intended to take the place of tools made for this purpose, although it will answer within its range, but rather for the man who, being without them, must make something quickly and cheaply which will answer his purpose.

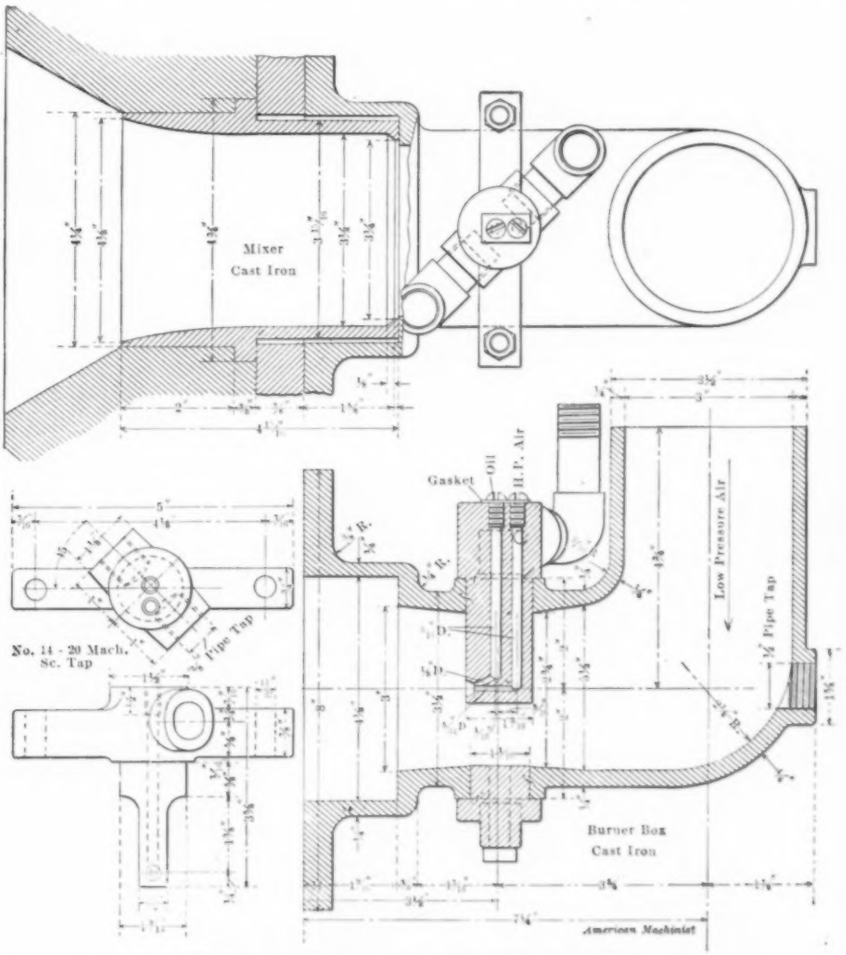
Chicago, Ill. ARTHUR F. KUNZE.

Fuel Oil Vaporizer

The sketch herewith represents in detail a high-pressure oil vaporizer or burner that has given good results in one of the largest forge shops in the middle West. It was designed by the superintendent and brought to its present efficiency after several months of experimenting. Several different types of high- and low-pressure burners were secured from prominent houses and fitted to the furnaces under the eye of the demonstrators that came to superintend the installations. We had all the facilities necessary to try each burner under conditions prescribed for it, namely, fan blast, 6 ounces; compressed air, 100 pounds; oil pressure, 40 pounds; and the use of reducing valves, pressure gages, a standard oil meter and the old reliable stand pipe or tank that could be filled with oil and the amount of oil used by each burner could be determined to an ounce.

The burner had to heat a furnace 3½x 5 feet and 14 inches high. No rules were laid down as to how the furnace should be built, and it could be fired from the front, back or side.

The cost of building the furnace; amount of oil consumed per hour; time required to bring furnace up to the required heat after lighting; control of the



DETAILS OF VAPORIZER FOR OIL-BURNING FURNACES

fire; and the time steel could be exposed to the flames with the minimum amount of scale, were the points that would decide for or against the burner.

With the low-pressure burners we found that the time required to light the furnace and raise it to the proper heat was one hour and fifteen minutes; the amount of oil consumed was nine gallons per hour. The oil not being properly broken up or vaporized, made it difficult to light and the furnace smoked so badly while heating up that we discarded this kind of burner early in the game. We then turned our attention to the high-pressure burners, which had their good points and burned about the same amount of oil.

They all required so much fan blast and compressed air that the amount of scale that formed on the steel gave us no end of trouble.

We then found that by reducing the compressed air to seven pounds and the oil to thirty, with just enough fan blast to keep a circulation in the furnaces, we could get ideal results with the vaporizer shown. Some of the others failed to work successfully on this amount of air and others that did, were discarded because the valve was difficult to clean when it stopped up.

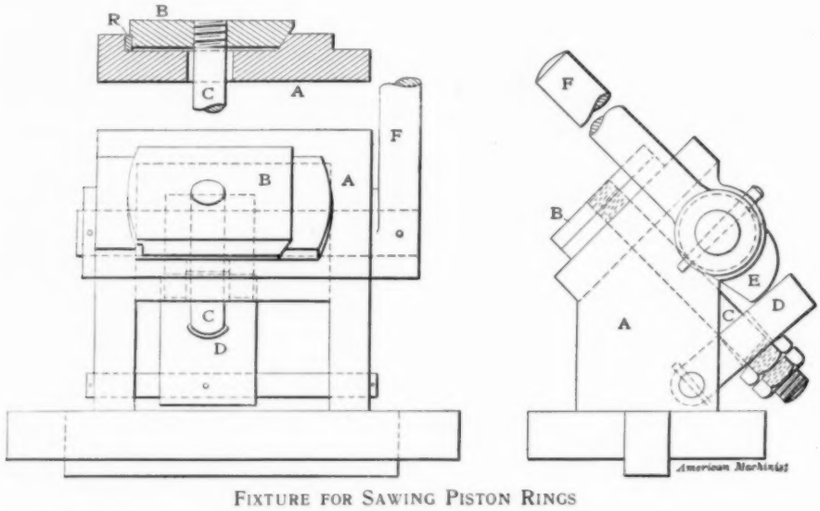
With the burners shown, it is not necessary to strain the oil and the heavy grades will work satisfactorily. The mixer casting is cemented to the furnace. As the burner box bolts against the same, a tight joint can be made with a small amount of asbestos cement and prevent the oil from running down outside.

The blast gate is fitted to the top of the burner box to control the blast and the oil and compressed-air pipes are fitted with needle valves. The mixer nozzle channels can be cleaned without disconnecting the piping by removing small screws on the top and inserting a wire, a feature that is very desirable. The hole in the back of the burner box enables the operator to see the effect of the blast on the fire and see the end of the mixer nozzle while cleaning the same. We have had good success with this burner for the last two years and have placed it in the hands of others to try. All speak in the highest terms of its efficiency.

Cleveland, Ohio. FORGEMAN.

A Piston Ring Sawing Fixture

This fixture is used for slitting small gasolene-engine piston rings. The rings are 3½ inches in diameter and ⅜ inch wide. They are sawed with a 7/32 inch milling cutter using a 45-degree cut.



FIXTURE FOR SAWING PISTON RINGS

The main body of the fixture *A*, is arranged for clamping to the milling machine table, the upper part of the body being set at an angle of 45 degrees. The movable piece *B* is used to clamp the ring, one side being cut at an angle to match a bearing surface in the raised portion of the fixture. A clamping rod *C*, with nuts for varying the operating length runs through the case-hardened plate *D*, which is supported on a pin. The hardened cam *E* is operated by means of the handle *F*. *C* is adjusted the proper length, so that, with a ring in the fixture, the clamp *E* is on its highest point, thus locking itself.

When cutting the ring *R*, the saw is run through the table and the clamp; this slot is not shown. This, of course, is only for the first ring and the fixture is afterward lined up so that the milling cutter fits the slot. A spring is used on rod *C* to throw up and loosen clamp *B*, when the lever *F* is thrown back to release cam *E*.

Chicago, Ill. D. S. MANN.

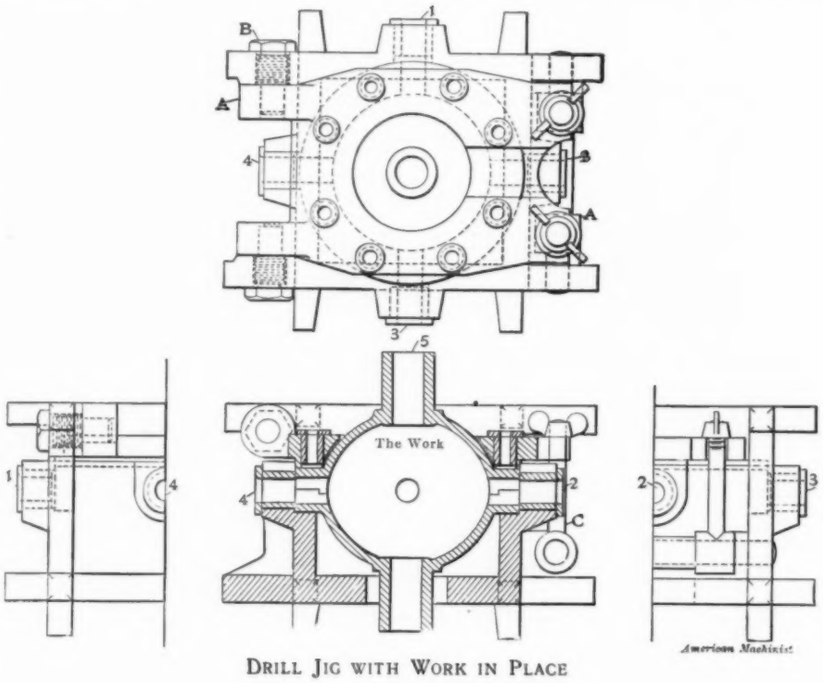
Jig for Differential Gear Boxes for Automobiles

This jig is designed to drill eight bolt holes and four holes for arms for crossheads. The bolt hole bushes are placed in the lid *A*, which is pivoted on screws *B*. When ready for drilling the differential box, the lid *A* is clamped down by means of the two swinging bolts *C*.

After drilling the bolt holes the jig is turned on to the feet on the sides, and holes 1, 2, 3 and 4 are then drilled. The jig is designed so that the holes are drilled at right angles to each other and they must also pass through the axis of shaft holes 5 and 6.

This jig has been of immense service in the accurate and cheap production of large quantities of differential boxes.

Glasgow, Scotland. H. L. CHERRY.



DRILL JIG WITH WORK IN PLACE

Cheap Punches for Gaskets and Liners

I have found the following method of making punches for cutting out paper liners, rubber gaskets, etc., to be very practical and cheap enough to permit of its use where only a limited number of pieces are to be cut.

Take one or more strips of annealed tool steel, about ½ inch wide, 1/32 to

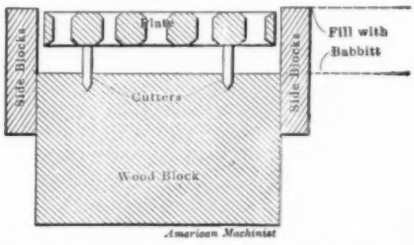


FIG. 1. POSITION OF PARTS WHEN READY TO BABBITT

1/16 inch thick and long enough to form both the external and internal outlines of the piece to be cut, and grind one side to a cutting edge. I have always used old hack-saw blades because they are easily annealed and always on hand when wanted. Make the angle of the cutting edge about the same as for a good keen cold-chisel.

Lay out the outlines of the piece to be cut on the end of a soft-wood block. This end should be smooth and about ½ inch larger than the work, but need not be the same shape.

Bend the steel strips to conform to the outlines and drive the cutting edge into the block a little deeper than the thickness of the material to be cut. Take a metal plate the size of the block, ¼ inch or more thick and drill it full of holes, about 5/16 inch in diameter. Countersink both sides. Place this plate on top of the steel strips, build up the sides of the block to the top of the plate and pour full of cheap babbitt. This will leave the cutting edge of the steel strips projecting from the babbitt the distance they were driven into the block, the babbitt supporting the strips on the sides and the plate forming a backing.

Fig. 1 shows how the punches are made. Fig. 2 shows a punch for an eccentric liner, the material for the punch being one brass plate 8x4x¼ inches, six pounds babbitt, four old hack-saw blades and four hours' time. The requirements for the punch shown in Fig. 3 are: One cast-iron plate 16x16x½ inches, 15 pounds babbitt, 9-foot by 3/64x½-inch spring steel, and 2¼ hours' time. In Figs. 2 and 3 the crosshatching shows merely the liner or gasket shape.

Erie, Penn. McKEE.

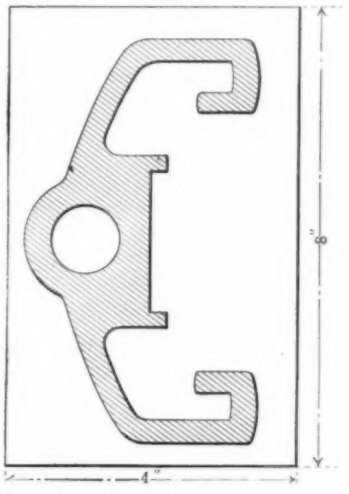


FIG. 2. PUNCH FOR PAPER ECCENTRIC LINER 0.012 INCH THICK. THREE CUT AT ONCE

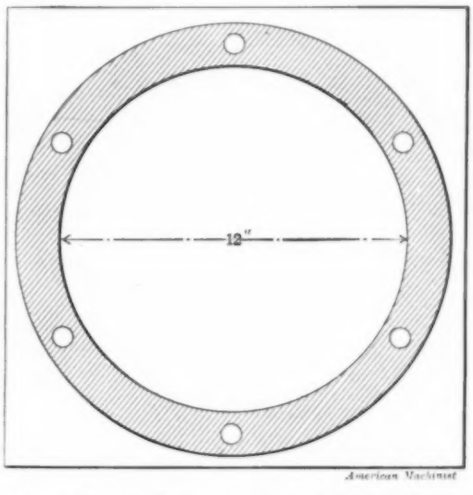


FIG. 3. PUNCH FOR 1/16 INCH RUBBER GASKET

Progress Is Not Necessarily Connected with Hustle

When a man who has been doing business in New York goes out into one of the smaller cities he invariably feels that things go slow. When the man from the smaller city goes up country for a week's vacation he notices the slowness of the country people. When the country storekeeper goes to the sea shore and has to wait for the tide to come in before he can get home at night he realizes that it is deathly slow. All these things are relative.

Transplant the man who has waited all his life for the tide to go out so that he could dig a peck of clams to a quick-lunch counter in the Liberty street region and he looks on the people as lunatics. Possibly they are.

The man who chipped and filed a lathe bed 50 years ago would look on the planer running with high-speed steel and quick return as a marvel, but would never suspect the man who designed it or the man who ran it, of being other than perfectly sane.

All of which leads up to the remarks that some of our progress in the matter of speed is wise and some foolish.

A HIGH-SPEED INCIDENT

We remember an incident about the time of the introduction of high-speed steel, where there were two men of about equal caliber working near each other in a shop. One was slow and fat and took to the high-speed steel. The other was thin and nervous and spry as a cat and clung to the old steel. One day a machine was ready to go out all but two driving studs that had been overlooked. A piece of stock was given to each of these two men and they were told that they could have an hour for the job.

In 25 minutes the slow man handed his to the boss in a leisurely way. Ten minutes later the hustler brought his over on the run. The first one had good smooth threads and the nut ran on without shake. The second was torn up in the thread and when smoothed down the nut could almost find its way on alone. The first man never turned a hair, the second was all excitement.

Half the rush and bustle of the great city is done for show, to create the idea that someone is working. The trolley cars and the express teams try to run you down in the street while up country they take you on and give you a ride. And yet you really get your express package over a given distance quicker in the country than you do in the city.

THE HUSTLE IN THE SHOP

In the shops there is the same condition. Your best workman comes in in the morning all excitement. He had to run to catch his train. He brought along a doughnut to eat on his way, which he swallowed whole. He ran for a car when he got off the ferry. He just escaped being run over by an ambulance and he got into the shop in a state of nervous apprehension. He grabs the shipper handle as if it were a base-ball bat and he slams it this way and that till you wonder the countershaft doesn't drop on his head. He tries his micrometer on his work, 0.006 large, he jams over the cross-feed crank and starts it up, 0.002 small. He backs out in a frenzy and starts in again, 0.004 large and by and by with repeated tappings he gets it right. He is working all the time but it takes him 10 minutes to get his size.

THE MORE LEISURELY SHOP

Now take your work to the shop up country. These men are dropping in half an hour early. Why? Because the shop is *their* club where they meet to enjoy each other's company. No one had to rush, some of them drove in five or six miles, summer and winter. The way you know the roads are drifted in the winter is because they get in earlier. They

started enough early to be sure to get there and they did it. They start up their work when the engine gets up to speed after a few leisurely turns. Then in a minute or two the seven o'clock whistle blows.

The best workman oils up before he begins, he reaches for the shipper handle as if he were shaking hands with an old friend. He tries on the micrometer, 0.006 large. He sets the graduated dial on the feed screw o 2½ thousandths and tries again, measures to be sure and taps the handle over the other half thousandth till it is just right. Time, 30 seconds. He busies himself cleaning up his bench getting a dog on the next shaft and whistles softly till the cut runs up. Does he worry? No. He knows that he measured that thing right. He knows his lathe turns straight because he knows which one of the marks he put on the tailstock to set it to. He just has a snap, thinking about the next job, and you get your job better done and quicker done than you did in the city.

We are all creatures of our environment. Transplant this country machinist into the city and inside a month the noise, confusion and devil-take-the-hindmost air of the city gets on his nerves and he is like the rest of them. Then his country employer comes into the shop and sees him hustling, or pretending to hustle, with the rest and he goes home to lay down the law to his other men and get them to work as fast as they do in the city. But he cannot do it any more than you can make a cow that was born to chew her cud, eat predigested breakfast food.

Springfield, Mass. ENTROPY.

A Lead Screw Cleaner for Engine Lathe

I designed a special cleaner for the lead screws of our lathes. Fig. 1 shows the front view of the lathe. Fig. 2 shows the front view of the cleaner, which is fixed to the half nut. Fig. 3 is the plan and Fig. 4 the side view. *A*, Fig. 1, is the lead screw; *E* and *F* the half nuts; *B* is a hard hair brush, and *C*, a comb.

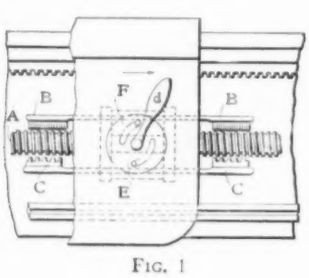


FIG. 1

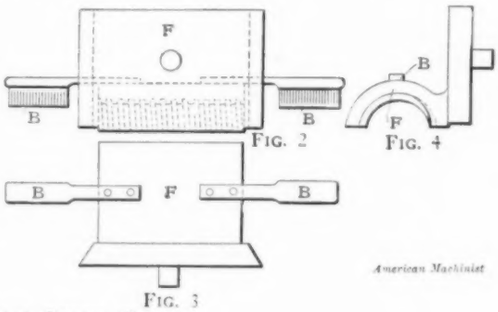


FIG. 2 FIG. 4

FIG. 3

A LEAD SCREW CLEANER

If we turn the handle *d*, Fig. 1, as shown by the arrow, the half nuts *E* and *F* engage the lead screw *A* and at the same time *B* and *C* are pressed on the lead screw.

As the screw turns, *B* and *C* automatically follow the thread and clean out the dirt or chips. The cleaner is fixed on both sides of the half nut, so that it works in either direction of traverse.

When the half nuts disengage the screw, the cleaner *B* and *C* are also freed from the screw.

This cleaner works very well. A cleaner on the same principle can be applied to clean the surface of the lathe bed.

Tokio, Japan. JAPANESE ENGINEER.

A Milling Fixture for Squaring Ends

The line cut shows a fixture designed especially for squaring the heads of screws, bolts, studs, pins, etc., especially when the index attachment is in use on some other machine.

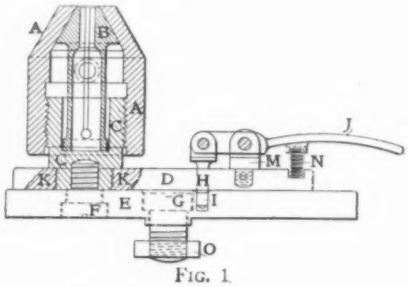


FIG. 1

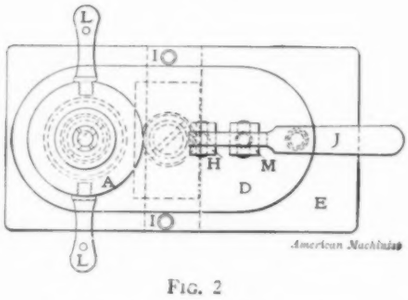


FIG. 2

MILLING FIXTURE FOR SQUARING

A is the bonnet which screws down on the chuck *B* thus clamping the parts to be machined. *B* is a regular spring chuck. *C* is the stud which the bonnet *A* screws on to. This is shown screwed into *D* which is cut away at *K* to show. *D* is the top plate which swings to either side, 90 degrees or can be used straight when milling slots. *E* is the base which by the aid of the screw *G* and clamp *O* is fastened to table of the milling machine. *F* is the binding screw which the plate *D* swings on. *H* is the stop pin which enters the holes *I*. *J* is the lever which, in connection with the butt *M*, controls pin *H*. *N* is a spring which keeps the pin down in the hole. *I* and *L* are two handles to turn the bonnet *A* down on to the chuck, thus clamping the work.

Boston, Mass. J. S. S.

An Eccentric Stud for Change Gears

When gearing up for screw cutting on the quadrant of a large lathe, using the ordinary change gear stud, the gears being heavy, and two of them on each stud, it is often very difficult to place them so that they mesh correctly. Fig. 1 is an arrangement for easily and surely placing them so that they gear correctly with one another: *A* takes the place of the ordinary change gear stud, slides up and down the quadrant and is locked in position in the ordinary way. If the wheels do not gear correctly, the eccentric stud *B*, part of which passes through the ordinary stud, is turned, thus throwing the bush *C* and the change gears further or less in gear as desired. The hexagon nut *D*, the wrench for which can fit the end of the stud at *E*, locks the stud *B* to *A* when the gears are in correct position. The gears and bush *C* revolve on the stud *B*. The throw of the eccentric stud is shown at *F G*. *X* is the quadrant. Fig. 2 is a set of change gears showing how the eccentric stud is applied.

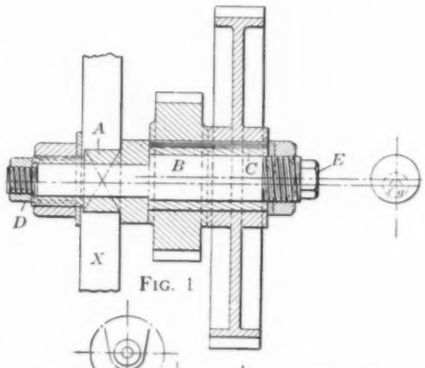


FIG. 1

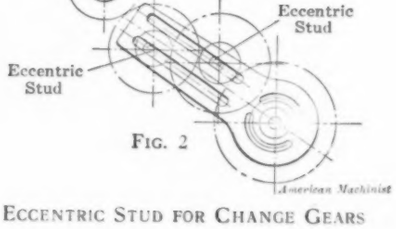


FIG. 2

ECCENTRIC STUD FOR CHANGE GEARS

Manchester, England. W. R. O.

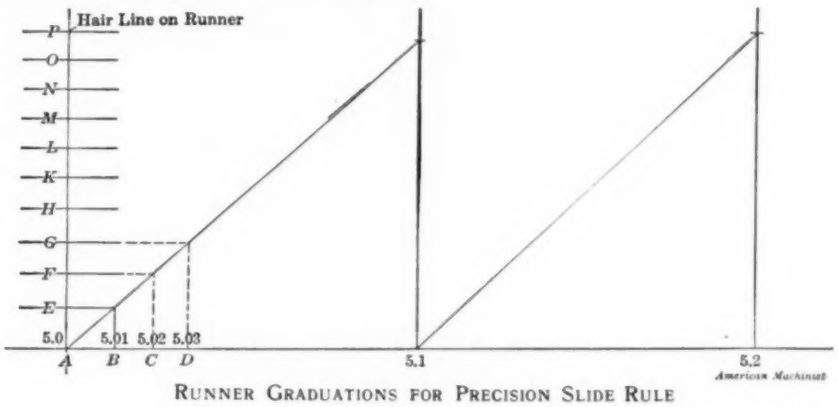
Discussion of Previous Question

The Precision Slide Rule

Letters from our readers showing how many men of many minds look upon various subjects opened up in previous numbers.

Referring to the question raised by Mr. Messner in his article on the above subject published on page 559, Vol. 33, Part 1, as to whether his method of graduating the runner glass would give absolutely correct results, the answer is that it would not. In order to be absolutely correct his method illustrated in Fig. 1 would have to be adopted.

After going into the matter I have come to the conclusion that by graduating the runner slide with equal spaces between the divisions, a satisfactory result would be obtained.



RUNNER GRADUATIONS FOR PRECISION SLIDE RULE

The reason that I say his second method is not *absolutely* correct is because the graduation required to read to the third place of decimals between, say 2.0 and 2.1, would not be quite the same as that required to read the third place of decimals at such a location as between 9.0 and 9.1. The difference would be infinitesimal, I admit.

Suppose, for example, we graduate the runner slide to enable us to read to the third place of decimals *between* 5 and 5.1.

Referring to the figure; if *B C D* represent the positions 5.01, 5.02, 5.03, the lengths on the slide would be

$$AB = log.\ 5.01 - log.\ 5.00 = log.\ \frac{5.01}{5} = log.\ 1.002.$$

$$AC = log.\ 5.02 - log.\ 5.00 = log.\ \frac{5.02}{5} = log.\ 1.004.$$

$$AD = log.\ 5.03 - log.\ 5.00 = log.\ \frac{5.03}{5} = log.\ 1.006.$$

The lengths *A E*, *A F*, *A G*, etc., on the runner slide must be in the same ratio as the lengths *A B*, *A C*, *A D*, etc. Therefore, the lengths of the graduations *A E*, *A F*, *A G*, etc., would have to be in the ratios shown by the following table:

$$AE = log.\ \frac{5.01}{5} = log.\ 1.002 = 0.000868.$$

$$AF = log.\ \frac{5.02}{5} = log.\ 1.004 = 0.001734.$$

$$AG = log.\ \frac{5.03}{5} = log.\ 1.006 = 0.002598.$$

$$AH = log.\ \frac{5.04}{5} = log.\ 1.008 = 0.003461.$$

$$AK = log.\ \frac{5.05}{5} = log.\ 1.010 = 0.004321.$$

$$AL = log.\ \frac{5.06}{5} = log.\ 1.012 = 0.005181.$$

$$AM = log.\ \frac{5.07}{5} = log.\ 1.014 = 0.006038.$$

$$AN = log.\ \frac{5.08}{5} = log.\ 1.016 = 0.006894.$$

$$AO = log.\ \frac{5.09}{5} = log.\ 1.018 = 0.007748.$$

$$AR = log.\ \frac{5.1}{5} = log.\ 1.020 = 0.008600.$$

That is, if the length of *A E* is considered 1.00, corresponding to 1.00,

	Y		Z
A F	will be 1.99,	corresponding to	2.00
A G	will be 2.99,	corresponding to	3.00
A H	will be 3.99,	corresponding to	4.00
A K	will be 4.98,	corresponding to	5.00
A L	will be 5.97,	corresponding to	6.00
A M	will be 6.97,	corresponding to	7.00
A N	will be 7.94,	corresopnding to	8.00
A O	will be 8.93,	corresponding to	9.00
A R	will be 9.91,	corresponding to	10.00

This table (column *Y*) shows how the runner slide would have to be graduated to give perfect results and the conclusion I come to is that if graduated with equal spaces between the divisions sufficient accuracy is obtained. The divisions at any other point on the slide will be slightly different and the equal divisions would be the best average. I rather think that Mr. Messner anticipated that the graduation would have to be more unequal than the column *A* shows to be necessary.

How I obtained the logarithm of 1.002 from a table giving the logarithms of numbers from 1 to 1000 may be of interest.

$$1.002 = 0.501 \times 2$$

$$\therefore\ log.\ 1.002 = log.\ 0.501 + log.\ 2$$

$$= \bar{1}.699838 + 0.30103$$

$$= 0.000868$$

The number 1.002 did not come with the limits of the table, but by using the above method the logarithms of 0.501 and 2 could both be obtained from the table and thus the logarithm of 1.002 is obtained.

W. G. DUNKLEY.

Manchester, England.

Cold Rolled Shafting

After reading Mr. Klein's contribution on Cold Rolled Shafting, page 973, Part 1, Volume 33, it does not seem clear what process of shaft making he had in mind at the time of his writing. I presume he meant the Brightman process, in which event, I can speak from experience, having turned and drawn several million feet of round bar steel, ranging in size from 5/16 to 2⅛ inches, also many thousand feet of shafting on engine lathes before the introduction of the new method.

At this time I wish to say that the term "cold rolled' as applied to this process is a misnomer, for it is either lathe turned or cold drawn, after which operation it is then put through the rolls for straightening and finishing, or straightening respectively. If the latter operation governs the terminology in the premises, then for conventionalities sake, we may call it cold-rolled shafting.

I am not prepared to believe that wrought-iron shafting has any point of superiority whatever, except in price, to either drawn shafting of 0.10 per cent. carbon, open-hearth or titanium steel at a 1/16-inch reduction or turned shafting from 0.10 to 0.40 per cent. carbon.

The cork-screw effect that Mr. Klein complains of, which occurs only in turned

shafting, can be promptly eliminated by a competent operator.

To secure a dead shaft it is essential that the stock is straightened before it is turned, but not necessary when it is to be drawn, for then it is self-evident that the glazed skin is uniform throughout, all previous sets or heads having been eliminated while passing through the drawing die.

Of course, it stands to reason that when a bar is finished, it is to be handled in such a way that no new set is developed or forced on it.

Chicago, Ill. A. KOLLER.

Pneumatic Holding On Tool

The accompanying sketch represents in detail a tool used in our construction department. It enables us to dispense with the old-style holder which was illustrated in the AMERICAN MACHINIST on page 737, Volume 33, Part 2, and also to get along without the man, in many cases.

The call for this tool was due to the necessity of driving rivets in close quarters, where the rivets have to be spaced exactly and show no tool marks on the heads when finished; places that it was difficult to hold a bar on the rivet head; and in places where standing room was limited.

When once set under a rivet and compressed air turned on, the tool will not slip and the backer up, or man that handles it, can get out of the way and give the man with the air hammer a chance to work.

We find that a larger number of rivets can be driven per hour with a smaller per cent. of bad heads. The plunger is machined to fit the rivet head so that the pressure exerted by the air hammer on the rivet is distributed evenly over the head and it cannot lose its shape.

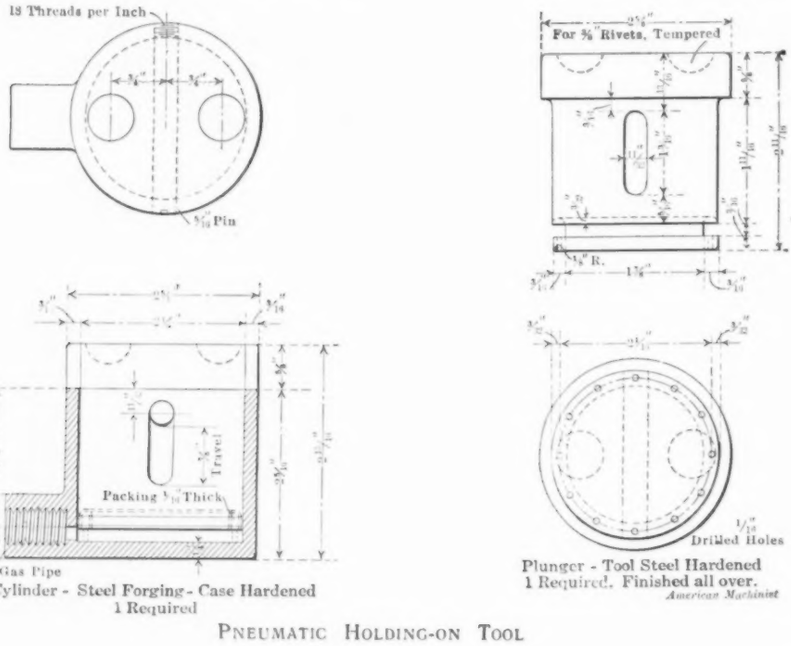
A piece of ⅜-inch pipe, 36 inches long, makes a good handle for the tool, as the air hose can be attached to the end of it. A three-way valve is used to control the plunger; by turning the handle the air can be turned into the cylinder or exhausted from it at the will of the operator.

Several plungers for different sized rivets can be used with one cylinder; and where the rivets must be spaced exactly, depressions should be machined in the plunger, as shown in sketch, the distance apart that is required. After the first rivet has been driven, we use it as a stop to keep the second rivet in the proper position.

We have several different sizes of these tools in use in our plant, and we think they are as far in advance of the old style tools as the air hammer is over the sledge and rivet set.

FORGEMAN.

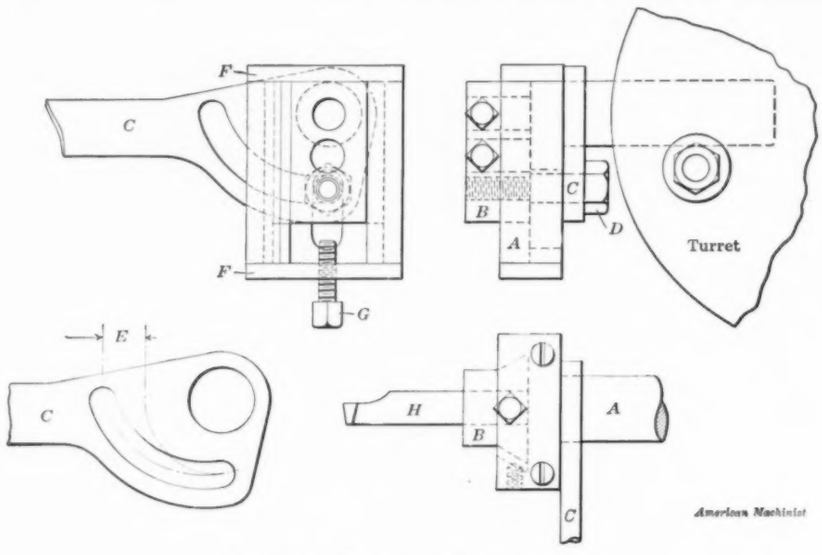
North Tonawanda, N. Y.



PNEUMATIC HOLDING-ON TOOL

Another Recessing Tool for Turret Lathe

On page 364, Volume 33, Part 2, J. W. Ellisson shows a recessing tool for turret lathes, and on page 748, C. Schwaeble submits another design for the same purpose.



A RECESSING TOOL FOR TURRET LATHES

Mr. Schwaeble, in his article, commenting on the position of the actuating cam as shown by Mr. Ellisson, says: "The arm which carries the cam lever I should think might be in the way of the operator."

Yes, as shown, it would be in the way in many cases, especially where a cross slide was used; moreover, it is in such a position that it would be impossible to use a jaw chuck, and this is also the case with Mr. Schwaeble's design, as the cam lever would foul the chuck before the tool reached its position. A weak feature in both designs is the swinging tool box, which allows (under some circumstances) the tool to dig in (but this is, I know, a question of opinion). The weakest point in both designs, in my opinion, is the fact that under certain conditions the operator might withdraw the turret while the tool was still in the recess, because after a certain point the spring will not force back the cam.

I came across a set of recessing tools that have several good points, and three of them have been in use for some years with every success.

The cut shows three views of the tool, and a clear view of the cam.

It will be seen that the holder *A* is dovetailed through to take the tool box *B* and is gibbed to take up wear. It is

also slotted through to clear the actuating pin *D*.

The cam lever *C* is bored to fit over the stem of *A* and is slotted to give the cam movement shown at *E;* this slot is a good working fit on the pin *D* after both are hardened. The pin *D* (not shown in front elevation) is screwed into the tool box *B* after assembling, and jams on the shoulder without tightening on *C*, which is thus free to move within the limits of its slot.

Both ends of *A* are blocked up by the plates *F*, each carrying an adjusting stop screw *G* (only one shown) to control the travel between the desired limits.

It will be noticed that there are two positions in the tool box *B* for the tool *H* and this makes the rig more general in its application.

The cam lever *C* is made to just clear as the turret is rotated, and of sufficient weight to always drop to its lowest position when released; the rig as originally made had a spiral spring to assist the lever to drop, but this was found unnecessary, as a normal handle will not stay in the up position when the handle is released.

The screws securing the tool *H* into *B* (shown only on plan) were carried above the level of *A* for free use of the wrench.

In operation the turret is advanced to the stop, then the cam lever *C* is raised until *B* strikes the stop screw *G* and the cam lever on release falls and disengages the tool from the recess.

It is impossible for the tool to dig in, as it is rigidly controlled both ways and the feed is very sensitive, there being no multiplying action, such as one gets in rigs of the swinging tool-box type.

WALTER G. GROOCOCK.

Woolwich, Eng.

Casting Bracket and Wheel Together

The job shown on page 1024 is an interesting one. There are quite a number of applications of this method. In the hardware stores we can buy little cast-iron C-clamps with cast screws in which the clamp has been cast around the screw. In making these, the screw is cast first, and then the thread is covered with a wash made of litharge and fine foundry dust, usually called "beam" dust because it is found on top of the beams in the foundry.

Another and more accurate job is the casting of such work as the steel balls in the brackets for the Almond right-angle drive. For work of this character I would use either of the following processes. The balls can be covered with two or three layers of baked Japan or a coat of ordinary shellac with a little burnt sand (parting sand) dusted over the shellac while still tacky. After the iron has been cast around the ball, the piece is soaked in kerosene and the ball worked loose with a bar through the ball. A little practice is necessary in order to get the correct thickness of coating to leave the ball free but not loose.

New York. E. A. DIXIE.

Hydraulic Cylinder Design

The article on page 578 on the design of hydraulic-press cylinders interested me greatly, as I have met with most of the troubles Mr. Jenkins mentions.

STRESSES

I have always been doubtful about the allowable stress in cast iron. Most authorities give the safe tensile stress as 3000 pounds per square inch for ordinary purposes, but give 6000 pounds and some 8000 pounds as the allowable stress in a hydraulic cylinder. Of course, the metal for this purpose is supposed to be of a better quality than ordinary, but where the foundry work is undertaken by a separate establishment, the superiority of the metal is too often only indicated on the bill.

Some customers specify double the working pressure as the test pressure, which to my mind is unreasonable as, even if the cylinder did fail, there is in most cases no danger to life, and one does not want to design all bolts, studs, columns, etc., to stand this excessive strain. I have persuaded several customers to reduce the test pressure to one and one half times the working pressure.

In my own practice I always use 6000 pounds as the safe working stress for cast iron and find that it agrees closely with the practice of large makers here.

DESIGN OF CYLINDERS WITH LUGS AND PROJECTIONS

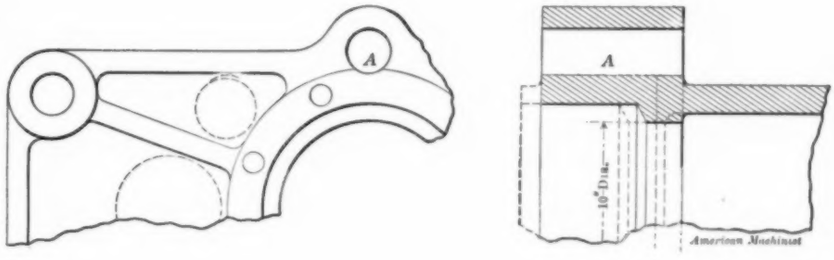
I have just had an unhappy experience in this direction with a cylinder weighing 2200 pounds. The ram was packed with a gland and we had to provide a very massive cylinder head for reasons which need not be gone into here. The cylinder head is shown in the sketch. We had a 450-pound riser cast on this end of the cylinder, but the metal had drawn away into the plate web at the back, and made the metal so spongy in the back of the stuffing box that the cylinder would not hold water, without the pressure. We had to scrap it. For the new one we altered the pattern by cutting large holes in the plate web (shown dotted) and bringing the 10-inch bore one inch forward, as the dotted lines show. We had a 700-pound riser on the second cylinder, and it was sound everywhere, except for a bad leak into the hole marked *A*. This we bored out, and drove in a steel bush, so making it tight.

SEALING CYLINDERS

Sal-ammoniac solution is what I have always used for sealing and found it to answer well, together with peening. Mr. Jenkins mentions the use of ferrofix and thermit. Could he give us some more information on this point?

When using studs for packing glands, I always make the length of thread in the cylinder equal to one and one-half diameters, which, of course, means special studs, but is a necessary precaution, to my mind. A precaution I have often seen neglected on horizontal cylinders is an air vent at the highest point of the bore. Could Mr. Stillman give us some more particulars of the amethyst choker he mentions in his article on hydraulic valves cut by the high-pressure water?

London, England. S. T.



CHANGE IN HYDRAULIC-CYLINDER CASTING TO GET SOLID METAL

Cleaning Belts

In your answer to an inquiry regarding the problem of cleaning oil-soaked belts, you gave two methods, I would suggest another method that has been found quite effective.

Coil the belt loosely in a tub of sufficient size and cover with whiting. Be sure that the whiting will get in between the layers of the belt, and it will be only a short time before the whiting will absorb the oil from the belt. It will then only need to be wiped clean to be available for further use.

Providence, R. I. D. D. DONOVAN.

What Should an All-round Machinist Know?

To Mr. Handley's query as to what should an all-round machinist know, which appeared on page 1029, I venture to reply that he should be equally efficient (or nearly so) on any work which is required to be done in the shop. He should understand the theory of all the mechanical powers and be competent to construct any machine containing all of them. He should also be able to coöperate with any workman that requires assistance or instruction in the performance of his duties. Considering myself the employer, these would be the required qualifications.

As an applicant for the position as an all-round machinist, I should think the ability to bore and turn taper, cut threads in the lathe, plane and fit dovetail, cut gears in the milling machine, run the boring mill, drill press and the universal grinder would justify me in making the application, but I would expect that the management have a foreman on the premises, who at least knew what he wanted done, and for the purpose of cooperating for the benefit of all. Yet this is what the management often fails to do.

Every journeyman knows that we have foremen who, for various reasons, are holding down the position for which they are not qualified. These men depend upon their ability to hire someone with more knowledge of the trade than they themselves possess. The experience of Mr. Handley's friend recalls an experience of my own. During the recent panic I spent three weeks analyzing the contents of a well known die book, in order to post myself on the best methods, in hopes of securing work of this class. The opportunity soon came, when I traveled 300 miles across a western State for the position.

Arriving at the shop, I found a complicated punch and die in the course of construction. This work had been started by my predecessor without any definite plans. That he had only a hazy idea as to what was wanted was evident from the fact that we assigned considerable of his work to the scrap pile. This fact seems to show that the foreman did not know what the workman was doing.

Before I started on the job the superintendent and foreman looked the work over, but, much to my surprise, they left me with practically no instruction as to what to do. Being thus thrown upon my own resources I saw a few operations on which to begin. In the meantime my mind was trying to develop a picture of the completed punch and die. A few days later I communicated to the foreman my idea of what was wanted. He looked up at me and remarked, "Now you have it!"

The information which I acquired from the die book was the vital factor, and the work was completed, but I am fully convinced that if there ever was a case of a foreman failing to qualify this was it.

Elgin, Ill. GUS HAESSLER.

Grinding vs. Air Cooling

Referring to W. H. Sawtell's article on "air-cooled" emery wheel on page 1073:

I have had some experience along these lines, and mention an instance which bears upon this particular question. Not so long ago a steel salesman remarked to me that if he could get a wheel for grinding blue-chip steel, he would be able to sell more such material to the small consumer than at present. I naturally inquired of him the nature of his complaint, and he advised that it was due to the grinding wheel cracking the steel, and causing it to break off in small portions.

We went to his place of business, and found that he was running a wheel entirely too fine and hard, causing the steel to burn and become heated easily. I put in a Norton Alundum wheel grain 46 grade N, and he was soon convinced that there was really a grinding wheel that would grind high-speed and blue-chip steel. The grinding in this instance was done dry.

The question for which Mr. Sawtell offers a remedy, really dates back many years ago. The manufacturers at that time used very hard wheels which did not fracture, or in other words, keep sharp. Thus the wheel became glazed, and the work was only rubbed instead of ground. Some manufacturers are using this type of wheel today, which they must of necessity hack, which is a most improper method of truing a grinding wheel.

The wheels now used in uptodate factories are much softer in structure than formerly, which allows them to fracture under the pressure of the work being ground. Of course, the harder the material, the softer the wheel, and *vice versa;* also the broader the contact the softer the wheel. The converse is likewise true.

My experience has taught me to use a much softer wheel than that used years ago; and I also have found that if the manufacturers would put their grinding troubles up to the wheelmakers, their output would be materially increased, and the cost of production lessened to a considerable degree.

Thus if Mr. Sawtell would use a softer wheel; one that would fracture and eliminate a good deal of the friction, which always causes the wheel to burn and glaze; he would not need to cut air-cooling places in the wheels, and would thereby be relieved of the added expense and time necessary for this operation.

New York City. S. H. MERRILL.

Drawing Board Templets

I sometimes wonder if the readers of the AMERICAN MACHINIST do not want to come back on me with the English boy's slang phrase; "Don't try to teach your grandmother how to suck eggs." I know I am continually trying to tell mechanics how to do things, and, notwithstanding with discouraging results, I am still disposed to keep at it.

On page 365 A. B. Howk shows a specially arranged set of templets for drawing handles, and on page 1076 T. J. S. Kishpaugh criticizes the method. The whole trouble with the plan is that A. B. H. only half finished the job. All templets of that character should have a reverse; that is to say, in the case of the handle assume one is to be drawn horizontal. With A. B. H's. templet the upper side can be drawn and inked as well as a line can be drawn over a tee square; but, if the underside is undertaken with the same templet, the draftsman must stand on his head or reverse the drawing board, and, in either case, wait for his ink to dry; but, with a reverse templet, the lower side can be drawn as well as the upper, and with no trouble about smearing.

I pointed out this feature when showing my templet for drawing round corners and fillets some two or three years ago in the AMERICAN MACHINIST, and while that little tool is the handiest thing about my drawing kit, I know of but one case where anyone has tried to profit by it, and then the draftsman spoiled the whole scheme by trying to improve it. In the place of four outside corners and four inside, for the same size radius he made four outside corners with 1/8-, 1/4-, 3/8- and 1/2-inch radius: but without inside to correspond. He made the inside 5/8, 3/4, 7/8 and 1 inch, spoiling the whole scheme. In making the templets, the convex corners need to be about 1/64 inch smaller radius than wanted, and the concave, 1/64 inch larger than wanted, to allow for pencil and pen.

Syracuse, N. Y. JOHN E. SWEET.

The advance in wholesale prices of late is clearly shown in a bulletin issued by the U. S. Bureau of Labor, based on statistics of 257 commodities covering the last 20 years. Until very recently the highest average prices were those of October, 1907. Then a steady decline took place until September, 1908, since which date the advance has been regular. The last prices in the bulletin are those of March, 1910, when the average was 7½ per cent. higher than in the previous year, 21 per cent. above that of 1900, and 49 per cent. above that of 1897. The greatest increase of late, 15 per cent. in 1909 as compared with 1908, has been in farm produce, and the next greatest, 4 per cent., occurred in lumber and building materials.

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American Machinist

Editorial

Elimination of Wasted Time

The elimination of wasted time is one of the most vital questions in the increasing of shop production. We are constantly looking for steels which will allow a higher cutting speed, for drills which can perform unheard of work in producing holes in metals, and other similar means of increasing the output, but we are apt to overlook the amount of time wasted between operations.

Every second in which the maximum number of cutting tools possible for the particular job, are not at work, means wasted time, though it is not always possible to prevent all of this waste on account of peculiar conditions in connection with the work.

It often happens that the percentage of time occupied in the actual drilling of holes is but a small fraction of the total time during which the work is under the machine or being handled in the drilling department. This is especially true in the case of comparatively large work which must be handled under a radial machine and in which the holes are both small and shallow. In such cases high-speed drills and drilling machines show a very small net saving and the increased first cost and maintenance must always be considered. If the time occupied in handling the work or in changing from one hole to the other can be reduced even 10 per cent., the total saving will often be more than we imagine.

The question of wasted time should be carefully borne in mind in selecting new machine equipment, as, after a machine has been bought, it is usually out of the question to economically remedy such defects in the machine itself. Many do not seem to realize the saving to be accomplished by rapid power traverse of the various parts which must be moved frequently. If these are controlled from the operator's position, and are convenient to use, a surprising amount of time will be saved every day in this way.

In the case of boring mills, milling machines, or other tools, where the parts to be moved are fairly heavy, a careful comparison of the work performed by machines both with and without rapid power traverse will soon show that they are worth many times more than the difference in cost. Men will run the heads or tables rapidly to the desired point and reduce the wasted time to a minimum.

This saving of time means more than the actual difference between hand and power operation because it requires quite an expenditure of muscular effort to do this by hand and reduces the operator's capacity by this amount. Further than this, a high-speed power traverse always has its effect on the movement of the operator and he moves more quickly in performing all his various duties. The quick power traverse becomes sort of a pace maker and an operator unconsciously keeps in step with it just as the fife and drum quickens the steps of marching men.

A careful study looking toward the elimination of unnecessary waste in the handling of work, as well as in other directions, will show much larger net results than seems possible at the beginning, and we believe that all will agree that this is a most desirable method of reducing the cost of production.

Selecting and Buying Machine Tools

There are many differences of opinion both in regard to the manner in which machine tools are bought and to the proper procedure when new machines are to be purchased. It is not so many years ago when the purchasing agent was all powerful in the selection of machine tools as well as other equipment and supplies. While this is still true in some quarters, there is a growing tendency toward making the purchasing department only a sort of clearing house through which all requisitions for material of any kind must pass, and which takes entire charge of making the purchases and seeing that they are delivered.

In the old days it was quite common for a shop superintendent to specify a certain lathe and to receive an entirely different make because the purchasing agent favored the other kind either through personal acquaintance with the salesman or on account of a lower price. In many places today, however, salesmen and builders of machinery are being referred by the purchasing agent to the mechanical head of the department needing new machinery, as it is being recognized that the man who is responsible for results should be able to select the machine with which to produce them. It is quite evident that the man who is to be held responsible for the cost of work

will not be apt to specify any higher priced machines than necessary for this purpose, and he should certainly be allowed to select the machines and tools which he must use in securing the desired production.

It is gratifying to note that this view is being taken by a number of the larger railways as well as manufacturing establishments, and instead of attempting to dictate what kind of machine shall be bought, the purchasing agent confines his attention to securing the desired equipment at the lowest possible cost and at the desired time.

As bearing still further on the question of selecting the machinery to be used, it is interesting to note the statement made by W. Osborne, on page 1196 of Part 1, present volume, to the effect that he is largely guided in the selection of new machinery by the recommendations of his men who are in closer touch with the machines in the shop than he can possibly be.

We believe that this is also true in many other shops, even in some of the very largest, and that it effectually disposes of the idea that machine tools and machine-shop equipment generally is selected in the office, and that the man in the shop, whether he be a foreman or a machinist, has nothing whatever to do with it.

There is also another point of view in regard to the purchasing of new machinery. A few works managers and mechanical engineers claim that they cannot be bothered with traveling representatives of builders of machine tools and other shop appliances and that they have no time to consult printed advertising either in a technical paper or in the advertising literature which is published by nearly every manufacturer. They usually contend that, knowing the machine in operation in their shops, they are able to select the best equipment for any enlargements or replacements which they may make, and prefer to be guided solely by their past experience.

We do not believe that this attitude will bear rigid analysis, as it entirely overlooks the possibility of new and greatly improved machinery being brought out since the purchase of their present equipment and it assumes that in some mysterious occult way, they keep in close touch with the best thought and development along machine-tool lines.

It seems to us that it is just as necessary to keep informed regarding the newest ideas along the line of machine-tool construction as any other part of machine-shop management, and we do not believe it is possible to do this except by keeping in constant contact with manufacturers' representatives, both in the shape of traveling salesmen and the so called silent salesmen, the advertising pages of the leading publications, and the special catalog of the manufacturers. In fact, some of our best friends, who are responsible for results in some of the largest industries are frank enough to risk hurting our pride by admitting that they always find valuable suggestions in the advertising pages as well as in the reading matter over which we cudgel our brains in so many different ways.

We believe the question of selecting the proper equipment for a shop, or any additions to it, is more important than many seem to realize. The sooner we find that, while all lathes may be good lathes, some are better adapted to our particular work than others, the sooner we shall have the largest production per dollar invested and the dividends which are so dear to the heart of all stockholders.

Official Report of Tool Builders' Convention

On July 12 we received a copy of the official report of the last semi-annual convention of the National Machine Tool Builders' Association, held in Rochester, New York, May 24 and 25 last.

Hearty congratulations are in order.

The average official report of a society's convention presents itself some six to nine months after the convention has been held; but here is a report that was prepared, printed, bound and distributed within some six weeks from the closing day of the convention—a record that many another society would do well to try and emulate.

The fact that the work has been done quickly does not at all imply that it has not been done well. On the contrary, we congratulate the Association again on the arrangement and appearance of the report. It is a commendable product of the printer's art.

Let the good work go on.

Trade School for Special Training

To educate young men in mechanical work of the highest precision, the Bausch & Lomb Company, Rochester, N. Y., manufacturers of machinery for all branches of the optical trade, surveying instruments, camera shutters and lenses, etc., will open, within the next few weeks, a training school in the Ritter building, on St. Paul street, offering a practical and theoretical mechanical course. It is planned to place the school in charge of foremen of the different departments of the concern while the scientific staff will look after the theoretical end of the training.

The action follows as a result of the inability of the company to find skilled mechanics. Heretofore it has been necessary to take men from similar concerns in the country and of late the company has sent to Europe for skilled labor.

The applicant must not be less than 16 years of age, he must be physically sound, of good habits and character, and must have received an education equivalent at least to that required for graduation from the Rochester public schools.

The rate of wages shall be as follows: To begin with 9 cents per hour, increasing as rapidly as, in the opinion of those in charge, the ability and progress of the student will warrant, until at the end of the term of work a maximum of 20 cents per hour is attained.

At the successful completion of the course a student is accepted as a regular employee, earning the wages paid to precision mechanics.

PERSONALS*

C. E. Foster who for the past three years has been doing special pyrometer work for the Taylor Instrument Companies, Rochester, N. Y., has returned to England.

George W. Peck, a member of the engineering staff of the Pelton Water Wheel Company, has been appointed mechanical engineer for the St. Louis, (Mo.) water department.

John H. Fox, until recently consulting engineer for the Frazer & Fox Company, Cleveland, O., has become chief engineer of the Pittsburg Plate Glass Company, Pittsburg, Penn.

R. S. King until recently general superintendent of the Hall Cronan Company, Dayton, Ohio, has joined the engineering department of the Indiana Steel Company, Gary, Ind.

Herbert L. Whittemore until recently a member of the faculty of the University of Illinois, has accepted the position of engineer of tests at the Watertown Arsenal, Watertown, Mass.

George Cormack, Jr., who has been in the employ of the Rockford Engine Works, as designer, is to take up work with the Independent Harvester Company, Plano, Ill., as superintendent of the gas-engine department.

Sylvester S. Howell, who has had a varied and extended experience in engineering work, has become associated with Paul M. Chamberlain, under the firm name of Chamberlain & Howell, Marquette Building, Chicago, Ill., to engage in a general consulting practice.

C. A. Tupper, for a number of years manager of the publication bureau of the Allis-Chalmers Company, has severed that connection to become manager of the Reliance Engineering and Equipment Company, Milwaukee, Wis. Mr. Tupper is succeeded by W. M. S. Miller.

*Items for this column are solicited.

New Tools and Shop Appliances

A New Full Automatic Twist Drill Grinder

Figs. 1 and 2 show front and rear views of a full automatic twist drill grinder, which has been brought out by A Mill, 96 West MacMillan street, Cincinnati, Ohio.

This machine grinds drills up to three inches diameter. The drill revolves continuously at a uniform speed and in grinding a two-lip drill oscillates twice in one revolution, from a center, which is exactly on the axis of the drill spindle. This oscillation, which is caused by a cam working on a stationary roller, produces the exact conical clearance of the drill lips.

The cam- or back-shaft is driven from the clutch shaft by means of a universal joint connection and rotates twice as fast as the drill spindle.

The drill also is reciprocated twice to and from the emery wheel by means of a cam. Its point remains in contact while grinding the clearance of one lip, about one-fourth of a revolution and it is away from the wheel during the time it oscillates back, until it has accomplished a half turn, after which the grinding of the other lip takes place.

This reciprocating motion also effects the automatic feed by ratchet wheel and pawl.

The emery-wheel frame is made oscillating to prevent the cutting face of the wheel from clogging up, and to effect uniform wear. The frame is provided with an adjustment screw to shorten or lengthen the connection with the eccentric, which allows the use of the entire face of the cup wheel and insures uniform wear. The emery wheel is 9 inches diameter by 1¾ inches grinding face.

Before inserting the drill, the spindle is brought to the end of its oscillating stroke by turning the hand wheel on the back shaft, until the arrow point on spindle bearing coincides with a mark on the spindle collar. A threaded hand nut with conical bore at the slit spinle end secures the drill after the lip of the drill has been set to a gage.

The spindle revolves in a rack sleeve, which is engaged with a pinion. The pinion shaft carries a hand wheel for quick approach and return of the spindle, also worm wheel, which is always engaged with a worm. This worm wheel is loose on the shaft, but can be secured to it by a friction disk and a hand nut for automatic feed.

The small hand wheel at the front end of the worm shaft, for hand feed, while the ratchet wheel at the other end furnishes automatic feed when the pawl is released from its catch. The automatic feed can be stopped instantly by throwing out the pawl.

An automatic stop can be arranged by having an adjustable pin on the drill spindle sleeve, which will strike the lower part of trip lever and remove the ratchet pawl.

For different sizes of drills, the distance of the center of oscillation is changed, according to a graduated scale,

ANY and all new or improved machines, tools, or shop appliances of interest to men responsible for results in machinery-making plants will be briefly illustrated and described here—the machine shop news.

A more full and detailed description will be given—when it is real news—if it can appear here first—before it is sent to other papers. All descriptions appear in ALL four editions of the paper—Weekly, Monthly, Weekly English and Weekly German.

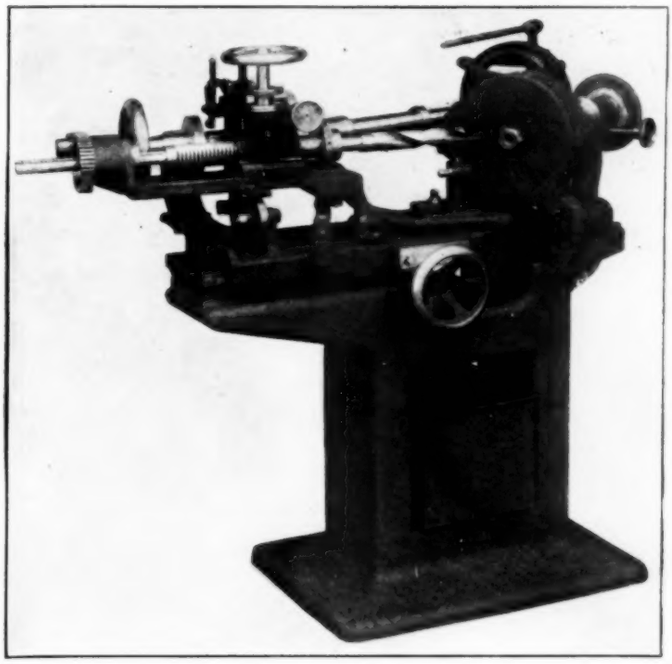


FIG. 1. FRONT VIEW OF FULL AUTOMATIC TWIST DRILL GRINDER

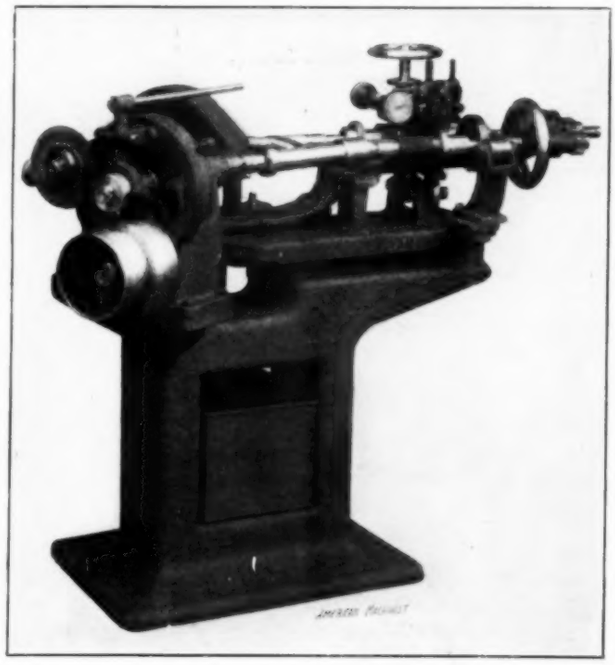


FIG. 2. REAR VIEW OF FULL AUTOMATIC TWIST DRILL GRINDER

by means of a rack, pinion and hand wheel in front of the machine.

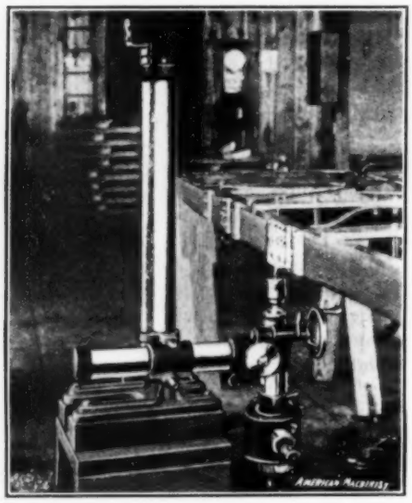
At the outer end of the emery-wheel spindle is a small, narrow wheel for hand grinding the thickness of the drill webs at the front of the drill.

Right- and left-hand drills can be ground and by the use of change gears drills of any number of lips can be readily ground.

A rotary pump is attached to the machine (but not shown in illustration) for wet grinding.

A Small Portable Electric Radial Drill

The line cut shows a portable electric radial drill manufactured by the United States Electrical Tool Company, Cincinnati, Ohio.



A Small Portable Electric Radial Drill

The drill spindle can be set at any angle in a vertical or horizontal circle. Power is taken from any convenient lamp socket. The tool is built in two sizes to drill from 0 to ⅞ inch, and from 0 to 1¼ inches.

A Universal Tool Grinder

Figs. 1, 2 and 3 show a J. E. Reinecker universal tool-grinding machine, which is handled by the Carpenter-Kerlin Gear and Machine Company, 77 White street, New York. The longitudinal and cross slides are mounted on a base which swivels on the knee of the machine. The knee itself can be swung on the column.

On the back end of the spindle a fixture is arranged for grinding thin milling cutters, and tools for which a hand rest is supplied. The machine can also be equipped with automatic power reverse for the table traverse.

If specially ordered either this machine or the larger size will be provided with spiral dividing head, with index plates and change gears for all pitches of spirals measured either in inches or millimeters.

Fig. 1. J. E. Reinecker Universal Tool Grinder

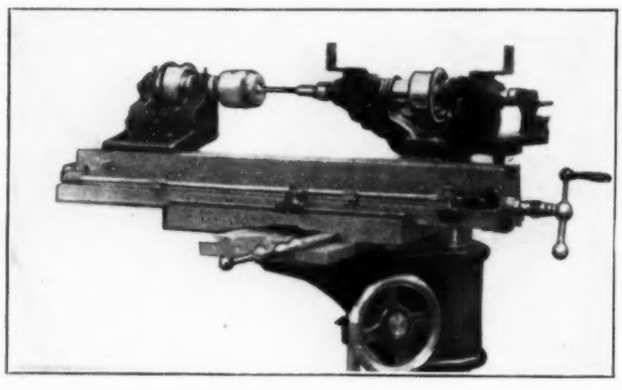


Fig. 2. Internal Grinding

Fig. 3. Cylindrical Grinding

It can also be arranged for motor drive or wet grinding.

Fig. 1 shows the machine, with automatic reversing power traverse to the table, set up for grinding the faces of the spiral flutes in a gear hob.

Fig. 2 shows the machine set up for internal and Fig. 3 for cylindrical grinding. As usually supplied the machine is equipped with a countershaft, one fixture for plain and angular milling cutters, two tailstocks, one headstock with driver, attachment for truing up the centers, one guiding finger with foot and tension holder for cord and weight, two hand rests, one cup-grinding wheel, four inches in diameter, one bevel, and one disk wheel six inches in diameter, and the necessary wrenches.

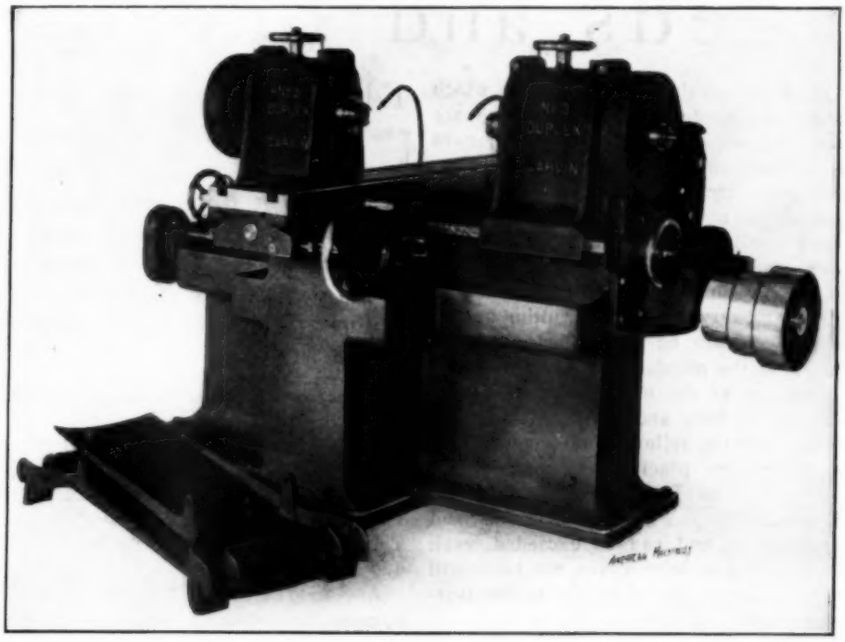
The Acme Turret Lathe

The halftone shows a line of turret lathes recently brought out by the Acme Machine Tool Company, of Cincinnati, Ohio. These machines are built to stand the strains due to the use of high-speed steel. They are furnished with or without power feed to the turret, also with and without extra capacity automatic chucks. The machines are provided with friction-geared head. A three-step cone for wide belt is used on these machines. They are provided with hexagon turrets, with the hole through the central stem of the same diameter as the tool holes. Tapped holes are provided for bolting tools to the turret faces, also independent adjustable stops are provided for each hole in the turret. The abutment for these can be shifted, allowing a slight further movement beyond any stop when desired without disturbing the adjustment of the stops. The power feed to the turret is of the geared type, giving four rates of feed instantly obtainable by shifting a lever. The distance from center of turret to the top of slide is made extra large to swing large dies and turret tools. The cut-off is provided with hand longitudinal adjustment and is made low to swing work of large diameter over the top of the slide. A double friction countershaft accompanies every machine.

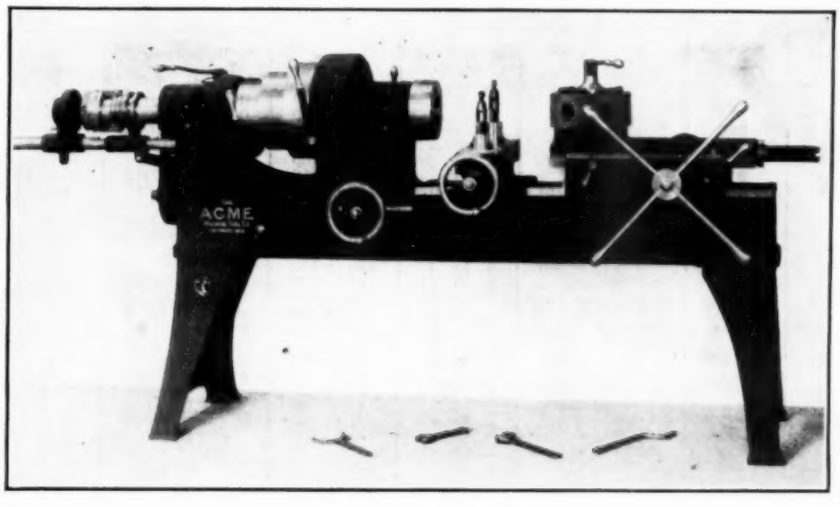
A Duplex Milling Machine

This machine was designed to give a feed of 60 inches without any deflection or cramping to the slide. The slide table is 64 inches long, and the saddle bearing carrying it is 60 inches long. The feed to the table is by means of a spiral rack. A large diameter square-thread steel worm made in halves (for taking up wear) engages in the spiral rack cut out of the solid on the underside of the slide. The slide shown in the illustration is made with grooves for special work. The regular pattern of slide has three standard T-slots. The two shield castings on the floor are bolted to the saddle, and drain all drippings from the overhang of the slide to the oil and chip channels cast all around the upper edge of the base. These channels communicate with one another, and have strainers located about half way from the top, leaving a clear oil space all around from which the pump draws its supply through a fine strainer and delivers it through flexible pipes to the work. The drive to the spindles is from a common splined shaft, through spur gearing, back geared 6 to 1 from the three-speed cone pulley. The cone is driven from an overhead countershaft. The taper holes in spindles are No. 11 B. & S. with positive slot drive. A draw rod reaches through from the rear end of the spindle to hold the taper shanks in their seats. The threads on spindle noses are 3¼ inches diameter, 3½ per inch, right hand and left hand.

The table has a working surface 12x64 inches; greatest distance between spindles, 27 inches; least distance between spindles, 4½ inches; adjustment of spindle over table from 1¼ to 9 inches; speed changes, 3; positive feed changes, 12. The machine is made by the Garvin Machine Company, of New York City.



A Duplex Milling Machine



Acme Turret Lathe

A Ratchetless Ratchet Wrench

The halftone and line cuts show the slickest wrench it has ever been our privilege to describe. Fig. 1 shows the wrench and Fig. 2 shows its action, the rounded end of one jaw allowing the wrench to roll around for the next grip, turning the wrench over reverses the direction of the ratchet-like movement. This wrench is made by J. H. Williams & Co., Brooklyn, N. Y.

FIG. 1. RATCHETLESS RATCHET WRENCH

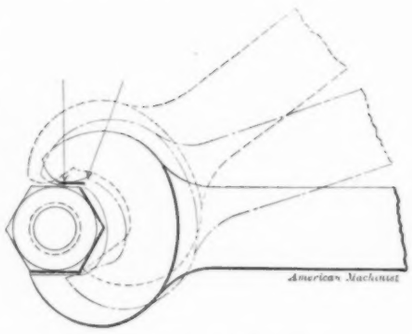


FIG. 2. HOW IT OPERATES

New England Foundrymen

The New England Foundrymen's Association held their first summer outing of the season on Wednesday, July 13, at Mount Tom. which is now a part of Holyoke. Members and guests from Boston, Fitchburg, Worcester, Providence and other points assembled in Holyoke and proceeded in a body to the top of Mt. Tom where an excellent dinner was served.

About 75 took advantage of the opportunity—as well as their friends, and all attested to the completeness of the arrangements made by Charles L. Newcomb, the chairman of the entertainment committee, as well as the work of President Anthony and Secretary Stockwell.

Feeds and Speeds for Drills

The remarkable drilling tests which are being made from time to time are apt to leave us a bit at sea in regard to suitable speeds and feeds for everyday use. The standard speed of 35 feet per minute cutting speed for carbon drills does us little good and even doubling this, or 70 feet a minute, is too slow for modern high-speed drills.

No arbitrary standard of cutting speeds and feeds can be established to fit all cases, as the physical and chemical characteristics of the metal, as well as the drilling machine and the drill, come into play. But the following table represents good average practice as recommended by the Celfor Tool Company, for their twisted drills. While these speeds and feeds have, and can be exceeded, even to doubling in some cases, the table will give good commercial results in the average cases.

Editorial Correspondence

The table gives the results of a large number of experiments made by well known high speed drill manufacturers and should form the basis of good shop practice.

It is believed that with a careful grinding, drills should last from 5 to 10 hours without sharpening at these speeds and feeds, but they should always be kept sharp. By so doing, they do better work and take less power.

Any drill which is run too fast will burn on the corners. The maximum safe cutting speed, in general, is independent of the rate of feed, but in hard materials drills are more apt to burn at smaller feeds (at the same speed) than in soft materials. The table is laid out for a cutting speed of 100 feet per minute in cast iron, 60 to 80 feet per minute in medium steel, and 40 to 60 feet per minute in hard steel. The torsional strength of the larger drills will permit of far greater feeds than those given in this table, but due regard has been given to the capacity and rigidity of available drilling machinery in constructing this table, the object being to give practical rather than theoretical figures.

Drills will wear more rapidly at the rates of drilling recommended than at lower rates, but the lowest cost of drilling will be secured by running the drills fast.

	CAST IRON OF AVERAGE QUALITY.			MEDIUM STEEL.			HARD OR VERY TOUGH STEEL.		
		FEED.			FEED.			FEED.	
Drill Size.	R.P.M.	Inches per Revolution.	Inches per Minute.	R.P.M.	Inches per Revolution.	Inches per Minute.	R.P.M.	Inches per Revolution.	Inches per Minute.
	1500	0.010 to 0.015	15 to 23	1200	0.008 to 0.012	9 to 14	600 to 900	0.006 to 0.008	3½ to 6
	1000	0.012 to 0.020	12 to 20	800	0.008 to 0.012	6 to 9	400 to 600	0.006 to 0.008	2½ to 5
	750	0.015 to 0.025	11 to 19	600	0.010 to 0.015	6 to 9	300 to 460	0.008 to 0.010	2 to 4½
	600	0.015 to 0.025	9 to 15	500	0.010 to 0.015	5 to 8	220 to 360	0.008 to 0.010	2 to 3½
	500	0.018 to 0.030	9 to 15	400	0.010 to 0.020	4 to 7	200 to 300	0.010 to 0.012	1¾ to 3½
	440	0.018 to 0.030	8 to 13	350	0.010 to 0.020	3 to 7	180 to 260	0.010 to 0.012	1¾ to 3¼
1	380	0.018 to 0.030	7 to 11	300	0.010 to 0.020	3 to 6	150 to 225	0.010 to 0.015	1½ to 3
1⅛	340	0.020 to 0.030	7 to 11	270	0.015 to 0.020	4 to 5½	140 to 200	0.012 to 0.020	1½ to 4
1¼	300	0.020 to 0.030	6 to 9	240	0.015 to 0.020	3½ to 5	120 to 180	0.012 to 0.020	1½ to 3½
1⅜	275	0.020 to 0.030	5½ to 8	220	0.015 to 0.020	3 to 4½	110 to 165	0.012 to 0.020	1½ to 3¼
1½	250	0.020 to 0.035	5 to 8	200	0.015 to 0.020	3 to 4	100 to 150	0.012 to 0.020	1½ to 3
1⅝	235	0.020 to 0.035	5 to 8	185	0.015 to 0.020	2½ to 3½	95 to 140	0.012 to 0.020	1 to 2¾
1¾	220	0.020 to 0.035	4½ to 7½	170	0.015 to 0.020	2½ to 3½	90 to 130	0.012 to 0.020	1 to 2½
1⅞	205	0.020 to 0.035	4 to 7	160	0.015 to 0.020	2½ to 3	80 to 120	0.012 to 0.020	1 to 2¼
2	190	0.020 to 0.035	4 to 7	150	0.015 to 0.020	2¼ to 3	75 to 114	0.012 to 0.020	1 to 2¼
2¼	180	0.020 to 0.040	3½ to 7	140	0.020 to 0.030	2½ to 4	70 to 108	0.012 to 0.020	¾ to 2
2½	170	0.020 to 0.040	3½ to 7	130	0.020 to 0.030	2½ to 4	65 to 102	0.012 to 0.020	¾ to 2
2¾	165	0.020 to 0.040	3½ to 6½	120	0.020 to 0.030	2½ to 3½	60 to 95	0.012 to 0.020	¾ to 2
2⅞	155	0.020 to 0.040	3 to 6	115	0.020 to 0.030	2¼ to 3½	60 to 90	0.012 to 0.020	¾ to 1¾
2¾	145	0.020 to 0.040	3 to 6	110	0.020 to 0.030	2¼ to 3½	55 to 85	0.012 to 0.020	¾ to 1¾
2¾	140	0.020 to 0.040	2½ to 5½	108	0.020 to 0.030	2 to 3½	55 to 80	0.012 to 0.020	⅝ to 1½
2¾	130	0.020 to 0.040	2½ to 5	104	0.020 to 0.030	2 to 3	50 to 77	0.012 to 0.020	⅝ to 1½
3	125	0.020 to 0.040	2½ to 5	100	0.020 to 0.030	2 to 3	50 to 75	0.012 to 0.020	½ to 1½

SPEEDS AND FEEDS RECOMMENDED BY THE CELFOR TOOL COMPANY.

Comments on Irrational Gear Design

By C. H. Logue

An illustration of the haphazard methods sometimes employed in gear design, and the consequences thereof. The evolution of the street-railway gear transmission.

There was a time when we had no good formula for the strength of gear teeth. If a drive was proved defective, one could always find a formula that could fit the case and show to his own satisfaction at least, that the gears were properly proportioned; the different authorities on this important subject varying as much as 500 per cent. in this respect. The Lewis formula is now acknowledged by nearly everyone to be correct for all practical purposes and should be used in designing gears unless we have definite knowledge to the contrary.

One of the first difficulties encountered on the subway trains in New York City was with the gears, which proved to be unequal to the work. These gears were 2½ inches diametral pitch, 5¼ face, the gear having 63 teeth and the pinion 20 teeth. After experimenting for some time with different designs, cast steel was abandoned for the gears and the teeth cut in a forged-steel rim installed, which was shrunk upon a heavy cast-steel center. This concentrated the trouble in the pinion. In order to prevent excessive breakage, it was found necessary to remove these pinions when the top of the tooth had worn to 3/16 inch, the original width being 0.33 inch. Even with this precaution, the teeth continued to break, this trouble being partly due to the twisting of the motor upon its base, allowing the pinion to bear upon one end, as almost invariably the teeth were broken from the inner face.

In order to remedy the trouble it was thought well to find out what strain was actually being applied to the pinion tooth. This was found to be 39,400 pounds per square inch, the maximum load being obtained during acceleration at a speed of 1168 feet per minute. As the elastic limit of the material used in pinion was about 45,000 pounds per square inch, the factor of safety was

$$\frac{45{,}000}{39{,}400} = 1.1.$$

This low factor of safety, in conjunction with the poor alinement of motor, was surely enough to cause the trouble experienced.

The problem on this road was, therefore, not one of gear mileage, but one to prevent absolute failure of the gears, the final solution being the adoption of a 20-degree short involute tooth, in conjunction with a material approximating 90,000 pounds per square inch elastic limit. This gave the gears a factor of safety of 3.2, which has proved satisfactory. I understand that no trouble has been experienced with the power of the motors, the weak point of the transmission being the gears. Of course, it is difficult to foretell the actual power required to propel a train, especially as the subway equipment was unique in many respects, yet should not the gears have been proportioned to transmit all the power of which the motor was capable?

Several high-speed roads have in late years had trouble of this same sort, the gears proving too light for the work after the road is put in operation. A large high-speed road in the West in which the gears had been designed to carry the full load of the motor experienced repeated fracture of the cast-steel gears. It was found, upon investigation, that the elastic limit taken by the drop of the beam, upon which the factor of safety had been based, was twice the real elastic limit of the material used. This investigation was made with an accurate extensometer, which records the first indication of permanent set.

These gears had a bearing the full length of the face and in some cases the break would start in the center of the face, indicating that that was the weakest portion of the tooth on account of the web in the center of the rim. It is evident, therefore, that the elastic limit as indicated by the drop of the beam, is not safe for use.

The first electric car had a five-horsepower motor located on the platform with the driver, the power being carried to the countershaft under the platform and thence to the car axle by means of a sprocket chain. This was thought to be the end of development along this line. Later the motor was placed under the platform and the car driven by bevel gears. Then double-reduction spur gears were used, the speed of the motor being high, a rawhide pinion being the driver and a 4 diametral pitch, 2-inch face, cast-iron spur gear being placed upon the car axle as a driven gear. Later malleable iron was introduced, and as the speed of the motor was reduced the connection was made direct, the proportion being adopted at that time was 3 diametral pitch, 4½- and 5-inch face. This proportion remained constant for nearly 10 years, being applied to all cars, the gears being selected according to the required power ratio, the bore being made to suit the axle. If a drive was required, it was simply a matter of selecting the gears from a stock catalog of a combined number of teeth to suit the center distance. If a change in the ratio was desired, more teeth were put in the pinion and less in the gear, in order to make the same total number as the former ratio, without respect to the power to be transmitted.

Some years ago it was found necessary, from general observation, to introduce another size; that is, 2½ diametral pitch, 5- and 5½-inch face. This size was applied in a general way to the heavier type of cars, and for a long period proved entirely satisfactory. For latter-day conditions, however, it is necessary to secure a better material and to carefully investigate the drive before installation. Also more attention must be paid to the cutting and spacing of the teeth. That the seriousness of the gear problem as applied to railway work is not fully appreciated, witness a recommendation recently made by the A. S. & E. Railway Association for gear standards:

For motors 45 to 100 horsepower, 3 diametral pitch, 5-inch face.

For motors 100 to 250 horsepower, 2½ diametral pitch, 5¼-inch face.

It is apparent that if a 2½ diametral pitch, 5¼-inch gear was applied to a 250-horsepower motor, there would be trouble unless an exceptionally good grade of material was used. This recommendation, however, does not cover this point. The ratio of the gear drives should also enter into this.

The speed of the cars has been increased from 20 to 75 miles per hour, weight has been increased from 8 to 40 tons, and the average diameter of the axle has been doubled, the bolts used on split gears have been increased, and, better still, it is now common practice to make the gear solid and press it on the axle. But the diameter of the gear cannot be increased, neither can the face. It would seem, therefore, that each case should be carefully investigated.

This method of selecting gears is not confined by the railway work. Is is common in many lines. Gears are often picked out "just a good sizeable size."

A young farmer once called on a dentist and said he wanted to get a set of teeth. "All right," said the dentist, "just get into the chair and I will make an impression." "Oh, no. I don't want them," says Reuben, "just pick out a good-sized pair. They're for mother."

This "formula" is often applied to the designing of gears. The designer gets out a catalog of stock gears and "just picks out a good-sized pair," as a general thing, making sure they are large

enough. The gears selected are often unnecessarily heavy, necessitating wide centers, high circumferential speeds, to say nothing of the increased cost. Sometimes, however, "mother's" capacity is underestimated and there is trouble. There would often be a great saving in time and money if an impression had first been made.

A machine once upon the market, in which the gear transmission has proved light in proportion to other parts, is rather embarrassing to the manufacturer and often necessitates the use of expensive material to overcome the weakness. Sometimes even this last recourse will not answer. It would seem, therefore, that it would be better to use a formula which is acknowledged by everybody to be the best obtainable, and then use our own judgment, if necessary.

Making Eccentrics

By Charles Markel

I would like to offer a suggestion in the making of eccentrics. An eccentric which is bored a little large for the axle, say, 1/32 inch, in all probabilities will never stay tight as the only contact the large half will have on the axle is the point of the set screws.

With the engine working hard or with the eccentric straps a little loose, it pounds the points of the set screws into the shaft and the eccentric is loose.

The only way to properly fit an eccentric to the axle is to bore it a trifle small or bore it with a thin liner between the two halves. Then when this liner is taken out it will hug the axle tight and perhaps be a little open, but it has a bearing on the axle all around and has very little chance of ever working loose.

A Slot Milling Problem

By Herman Stoll

Being interested in knitting-machine manufacture, I would like to inquire through the columns of your journal as to the best possible way of milling the finer divisions of needle slots without tearing out the thin walls left standing and bending the cutters, a difficulty which is now, and has been for a long time past, experienced in gang-milling plates containing from 13 to 16 slots to the inch.

This may seem like a simple operation but as a matter of fact I do not find it so, therefore, would like some light thrown on this "needle-plate milling."

Increasing Shop Capacities

Metal Working

The Moline (Ill.) Pump Company will erect a new plant on another site.

C. B. Rice, Garyville, La., is erecting a new foundry and machine shop.

The Monarch Electrical Company is building a factory at St. Lambert, Que.

The More-Jones Brass and Metal Company is erecting an addition to its plant.

The Baxter Stove Company, Newark, Ohio, will erect two additions to its plant.

The Southworth Machine Company, Portland, Me., is erecting a new factory.

A fully equipped foundry will be added to the Moline, Ill., manual training school.

The Pacific Garage, 172 Pacific street, Brooklyn, N. Y., was destroyed by fire.

The Midland Motor Car Company, East Moline, Ill., plans an addition to its plant.

Ground has been broken for the Badger Foundry on De Koven avenue, Racine, Wis.

Work has been started on a new plant for the Velie Motor Vehicle Company, at Moline, Ill.

The Buckeye Stamping Company, Columbus, Ohio, will erect a new one-story building.

The M. C. Railway is making extensive additions to its roundhouse, etc., at St. Thomas, Ont.

The Boston State Hospital, Mattapan, Mass., has had plans prepared for a machine shop.

The Hess Spring and Axle Company, Cincinnati, Ohio, is planning an addition to its plant.

The Marshall & East Texas Railway Company will build a machine shop at Marshall, Texas.

The Motor Specialties Company, Waltham, Mass., is equipping a building on Whitney avenue.

Parker & Chandler, Zanesville, Ohio, will establish a shop for furnace, tin and sheet-iron work.

Richard Mackler, Spillway Hotel, Gatun, C. Z., would like catalogs of machine tools in general.

News items for the sales department—where more equipment will be needed. Authentic news is solicited for this department, not rumors or gossip—facts.

James Craig, Jr., Jersey City, N. J., manufacturing gas engines, will build a new $25,000 factory.

The roundhouse of the Montana, Wyoming & Southern Railway, at Belfry, Mont., was destroyed by fire.

The Pressed Steel Company, Detroit, Mich., is erecting an addition to be used for assembling purposes.

The Crompton & Knowles Loom Company has let contract for an addition to its plant in Providence, R. I.

The Andrews Wire and Iron Works is to increase its capital stock to provide for enlargement of its plant.

It is reported the Griffin Car Wheel Company, of Chicago, is planning to erect a plant in Salt Lake City.

The Exeter (N. H.) Machine Works will establish a department for the manufacture of commercial motor cars.

The Hart-Parr Gasoline Engine Company, of Charles City, Iowa, will establish a plant at Portage La Prairie, Man.

The plant of the Oliver Chilled Plow Company, at South Bend, Ind., was damaged by fire to the extent of $40,000.

Deere & Webber Company, of Minneapolis, Minn., will build an addition to its farm-machinery plant at Moline, Ill.

Fire destroyed the plant of the Ohio Shovel and Stamping Company, Canal Dover, Ohio. Loss, $150,000. Will be rebuilt.

The Rice & Adams Company, Buffalo, N. Y., manufacturing dairy machinery, is erecting a foundry building at its plant.

The Henry B. Lewis Structural Iron Works, Detroit, Mich., will erect a new plant at Ferry avenue and Roby street.

The Frazer Manufacturing Company, Jersey City, N. J., will erect a new factory for the manufacture of coffee machinery.

Root & Van Dervoort Engineering Company, East Moline, Ill., has increased its capital stock and will enlarge its plant.

Fire destroyed the plant of the Cox Brass Manufacturing Company, Albany, N. Y., making automobile specialties. Loss, $20,000.

The American Automobile Company, Beatrice, Neb., is planning the establishment of a new factory in the South or Southwest.

The B. F. Goodrich Company, Akron, Ohio, is erecting a three-story building, which will contain machine shop, garage, tin shop, etc.

The Thomas Davis Estate, Boise, Idaho, is to erect a building for M. J. Briggs, of Denver, Colo., to be used as an iron manufactory.

Sam M. Card, Mt. Pulaski, Ill., has invented a rotary pump jack, and proposes to establish a factory for the manufacture of same.

The Lapointe Machine Tool Company, Hudson, Mass., has awarded contract for the construction of a three-story addition to its plant.

The American Steel and Wire Company, Chicago, Ill., is said to be planning improvements at the Rockdale plant to cost about $150,000.

The Obenberger Drop Forge Company, Milwaukee, Wis., is said to be contemplating the installation of steam hammers and other equipment.

The Jewell Steel and Malleable Company, Buffalo, N. Y., recently incorporated, is having plans prepared for a plant on a site still to be secured.

Kuhn Brothers will open an automobile garage and repair shop at Youngstown, Ohio. The concern will be known as the Auto City Garage Company.

The Moline (Ill.) Plow Company is building an addition to its blacksmith shop and plans the erection of eight- or ten-story addition to its plant.

The Standard Sanitary Manufacturing Company, Louisville, Ky., has had plans completed for a new $10,000 building to be used as a machine shop.

The Green Fuel Economizer Company, Matteawan, N. Y., has awarded contract for the erection of a new fan shop to replace the one recently burned.

The West Shore Railroad has purchased land in North Bergen, N. J., on which machine shops, blacksmith shop and freight yards will be erected.

The Mutual Wheel Company, Moline, Ill., is planning additions to its present plant and an auxiliary plant at East Moline, for which site has been purchased.

The Central Railroad of Pennsylvania has appropriated $150,000 for improvements to its shops at Ashley, Penn., including a large addition to its roundhouse.

B. B. Hoffman, Jack Cavin, J. M. Calkins, of Toledo, Ohio, have organized an automobile company, which will locate near the Jefferson hotel, Bryan, Ohio.

The Bailey Motor Company is erecting a three-story building at Hazleton, Penn., for the manufacture of automobile machinery, repairing and garage purposes.

The Grant & Wood Company, Chelsea, Mich., has let contract for the erection of an addition to be used for the manufacture of steel balls for ball bearings.

Arrangements for locating the Brodessor Motor Truck Company, of Milwaukee, in Juneau, Wis., have been completed and the plant will be erected at once.

Twohy Brothers, Portland, Ore., railroad contractors, have purchased additional land on which will be erected a plant, including machine shops, warehouses, etc.

The Standard Welding Company, Cleveland, Ohio, has secured a permit for the erection of a $75,000 factory at Woodview avenue and West Seventy-sixth street.

The Foote-Burt Company, Cleveland, Ohio, manufacturing drill presses, etc., will erect a three-story addition to its plant. Considerable new machinery will be installed.

The Gaeth Automobile Company, Cleveland, Ohio, has incorporated as the Gaeth Automobile Company, of Pittsburg, and will build a plant in the vicinity of East Pittsburg.

Cyrus E. Mead, Dayton, Ohio, has invented and patented a new automobile engine and is reported to be interested in the organization of a company for the purpose of manufacturing same.

The Cleveland (Ohio) Motor Truck Company, recently incorporated, will equip a plant for the manufacture of gasolene and electric motor trucks. Offices are in the New England building.

The Industrial Development Company has made arrangements to erect in Industria, its suburb, north of St. Joseph, Mo., plants for the Specialty Shoe Company, and the King Foundry Company.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids August 16, for one gear-hobbing machine for the Puget Sound navy yard, as per Schedule No. 2702.

The Strong, Carlisle & Hammond Company, Cleveland, Ohio, manufacturing machinery, etc., has secured a permit for the erection of a $10,000 factory at 1838 East Thirty-eighth street.

The Baldwin Forging and Tool Company, of Columbus, Ohio, will locate in Parkersburg, W. Va., where a new plant will be erected. The company manufactures steel shovels and scoops and employs 400 men.

The Griscom-Spencer Companq, 90 West street, New York, which recently acquired the plant of the Goubert Manufacturing Company, at Bergen Point, N. J., will probably require additional machine-tool equipment.

The Stockholm Pipe Fitting Company, Birmingham, Ala., will be absorbed by a new company to be known as the Birmingham Valve and Fitting Company. Site for its plant has been secured in East Birmingham.

The Uhlig-Gunz Company, a new concern capitalized at $150,000, has purchased site at Arlington, N. J., on which a typewriter factory will be built. Oscar F. Gunz and R. W. Uhlig, of Rutherford, N. J., are president and vice-president, respectively.

The Senn Pressed Steel and Hoe Company, Birmingham, Ala., capitalized at $150,000, will establish a plant at East Birmingham, to manufacture hoes, etc. Edward Senn, of Egg Harbor City, N. J., is president and A. M. Wallace, of Birmingham, secretary and treasurer.

The Grip Nut Company, South Whitley, Ind., is increasing its shop capacity and would like to receive quotations on automobile-tapping machines for small hexagon nuts, nut-facing machines, thread-milling and relieving machines. The company also contemplates making its own taps in the near future.

The Wolverine Motor Car Company, of Mt. Clemens, Mich., has been absorbed by the Alpena Motor Car Company, of Alpena, Mich,. D. D. Hanover is president; Wm. Krebs, vice-president; W. B. Robeson, secretary-treasurer; C. H. Munneley, purchasing agent and H. G. Schworppe, engineer and master mechanic. The company is now building its plant and will shortly be in the market for special tools and labor-saving machinery and appliances common to automobile factories.

General Manufacturing

The city of Yukon, Okla., voted $30,000 for water works.

S. M. Swenson & Sons will build a cotton gin at Spur, Tex.

The city of Decatur, Neb., is contemplating a waterworks system.

The Roman Stone Company will build a plant at Toronto, Ont.

The Hotel Rudolf, Atlantic City, N. J., will install two additional poilers.

Mannsville, Okla., will vote an issuance of $20,000 bonds for water works.

The town of Munday, Tex., voted to issue $10,000 bonds for waterworks.

Fire destroyed the saw mill of Richards & Co., Campbellton, N. B. Loss, $130,000.

The Cudahy Packing Company is erecting a new building at Portland, Ore.

The city of Belleville, Ont., will completely equip a new electric-light station.

The Anderson (Okla.) Glass Company will remove its plant to Okmulgee, Okla.

J. W. Almack, of Coshocton, Ohio, is considering the establishment of a basket factory.

The Davenport (Iowa) Ladder Company will erect a new two-story factory.

Lees & McVitty, Salem, Va., are having plans prepared for an addition to their tannery.

The Kokomo (Ind.) Glass Company is looking for another location for its plant.

The city council, Madisonville, Ky., voted in favor of installing a system of water works.

The Pennsylvania Globe Gas Light Company, Philadelphia, Penn., will erect a new factory.

The Snyder (Tex.) Ice, Light and Power Company will build a new power house.

The New Haven (Conn.) Auto Top and Body Company is erecting a new building.

The Mason Box Company, Attleboro Falls, Mass., will erect an addition to its plant.

The Faber Pencil Company is erecting a five-story factory on Kent avenue, Brooklyn, N. Y.

The American Silk Spinning Company, Providence, R. I., will erect an addition.

The lumber mills of Hill Bros., Truro, N. S., were destroyed by fire. Loss, $100,000.

The Columbia Narrow Fabric Company, Shannock, R. I., will install new machinery.

The Zanesville (Ohio) Grain and Builders' Supply Company is erecting a new building.

Fire destroyed the E. E. Pitman handle factory, at Logansport, Ind. Loss, $10,000.

The Wheeling (W. Va.) Traction Company will soon start work on a new power house.

The Windsor Shirt Company, capitalized at $40,000, will equip a factory at Windsor, Ont.

Plans are being drawn for a new plant for Waite, Thresher & Co., jewelers, Providence, R. I.

The Root Piano Company, Rochelle, Ill., is trying to find suitable site for a new factory.

The Cannelton (Ind.) Sewer Pipe Company is looking for a suitable location for a branch plant.

The Peoples Power Company, Moline, Ill., is building a $500,000 gas- and electric-light plant.

The city of Hartselle, Ala., will vote on issuance of $28,000 bonds for electric-light plant and water works.

The Central Silk Manufacturing Company, Siegfried, Penn., is building a two-story addition.

The Massillon (Ohio) Rolling Mill Company has increased its capital stock and will enlarge its plant.

Fire destroyed the plant of the Pullan Paper Company, Winnipeg, Man. Loss, $20,000.

The furniture factory of Batez Bros. & Co., Berlin, Ont., was destroyed by fire. Loss, $30,000.

The plant of the Selma Milling Company, at Hamilton, Ohio, was burned. Loss, $100,000.

The Nelson McCoy Sanitary Stoneware Company will build a new factory at Roseville, Ohio.

R. A. Reitz, Evansville, Ind., chair manufacturer, is looking for suitable site for a new factory.

The Providence (R. I.) Dyeing, Bleaching and Calendering Company will enlarge its boiler house.

Plans for a water works system for Conway, Ark., have been accepted and bids will be advertised for soon.

The plant of the Harquat Woodworking Company, Campbellton, N. B., was destroyed by fire. Loss, $60,000.

Plans have been prepared for a carpenter shop and laundry for the Boston State Hospital, Mattapan, Mass.

The Arnold-Althans Company, bakers, Providence, R. I., will spend about $30,000 on improvements.

The Denney Tag Company, West Chester, Penn., has let a contract for the erection of a two-story addition.

Fire destroyed the plant of the Ranier Lumber Company, at Ashford, Wash., causing a loss of $25,000.

The wool-pulling plant of Jas. C. Malone & Co., Jersey City, N. J., was destroyed by fire. Loss, $35,000.

A glass plant will be built at Bartlesville,

Okla. R. M. Patterson, of Independence, Kan., will be manager.

Richard Mackler, Spillway Hotel, Gatun, C. Z., would like catalogs of small steam engines and boilers for a 24-foot boat.

Cornell University, Ithaca, N. Y., has plan completed for the erection of a chemical laboratory to cost about $50,000.

Improvements to the extent of $200,000 will be made to the water, light and sewer systems at Altus, Okla.

The Dominion Abrasive Company will erect a factory in New Toronto, Ont., for the manufacture of emery wheels.

The city of Lake Arthur, La., will install a small system of water works. Address, J. B. Streator, chief fire department.

The city of Oceanside, Cal., will vote on the issuance of $15,000 for improvements to its municipal water system.

The plant of the Scott Lumber Company, at Magagnadavic, New Brunswick, was destroyed by fire. Loss, $100,000.

Contract has been let for the construction of a new plant for the Gardner Machine Company, in South Beloit, Wis.

The Morley Button Manufacturing Company, Portsmouth, N. H., will build an addition to be used as a cooling room.

The city of De Soto, Mo., contemplates installing a lighting system in connection with its water works. Ward Cunningham, mayor.

The kilns and box factory of the Ash Grove (Mo.) Lime Company were destroyed by fire. Loss, $10,000. Will be rebuilt.

Fire destroyed $20,000 worth of machinery in the Forest City Laundry Company, London, Ont. Will be replaced at once.

The General Electric Company has let contract for another addition to the power house at the Stanley plant, in Pittsfield, Mass.

The city of Dexter, Mo., is considering the construction of water works. Fuller-Coult Company, Chemical building, St. Louis, engineers.

The proceeds of a $16,000 bond issue will be used for machinery and equipment for the Jackson, Ohio, municipal electric-light plant.

Couch Bros. Company, Cincinnati, Ohio, has taken out a building permit for a $25,000 factory for the manufacture of horse collars.

Henry McDonnell, of Huntsville, Ala., is interested in a new canning factory to have a capacity of 10,000 cans per day to be erected in Cuba, Ala.

The Monarch Printing Company, Quincy, Ill., is preparing to erect a new building, which with equipment, will cost about $15,000.

The Mississippi Glass Company, of St. Louis, Mo., has secured site at Vandalia, Mo., on which it will erect its main fire-brick plant.

The Galesburg & Rock Island Traction Company will build a power plant at Milan, Ill. W. C. McWhinney, Galesburg, Ill., is president.

J. A. Corrier, of Columbus, Ohio, has purchased the plant of the Vinton Brick and Tile Company, at McArthur, Ohio, and will install additional machinery.

The Northern Illinois Electric Railway Company has purchased property at [illegible]ter, Ill., on which a large power house will be erected.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m., August 15, for water meters and steel billets as per Circular No. 597.

A new municipal electric-light plant is to be erected at Decatur, Ill. C. N. Hastings is chairman of the water and light committee. D. W. Mead, engineer.

The Acheson Oildag Company, a subsidiary of the International Acheson Graphite Company, of Niagara Falls, N. Y., will build a plant at Port Huron, Mich.

Latest developments indicate that the new $2,000,000 power house of the Northern Ohio Traction and Light Company will be located at or near Cuyahoga Falls.

Bids will be received August 4 at the office of the city clerk, Gadsden, Ala., for building new waterworks plant., for which $60,000 bonds were voted recently.

The Abbatoir boiler house and power plant of the Columbia Cotton Oil and Provision Company, at Relee, Va., were destroyed by fire. Loss, $200,000. Will be rebuilt.

The Niagara Lead and Battery Company, Niagara Falls, N. Y., will increase its plant ten times the present size. The company manufactures all kinds of storage batteries.

The Omaha & Council Bluffs Street Railway Company, Omaha, Neb., has awarded contract for the erection of an addition to its power plant, which is to cost about $600,000.

The Northern Texas Traction Company will install additional equipment in its power house at Handley, Tex., including 3000-kilowatt turbine and boilers. Will also make additions to substation.

The Linderman Box and Veneer Company, Eau Claire, Wis., has commenced the erection of a new factory to replace the one recently destroyed by fire. This, with equipment, is to cost about $50,000.

Proposals will be received at the Department of Justice, office of superintendent of prisons, Washington, D. C., until 10 a.m., July 29, for boiler feed pump for the penitentiary at Atlanta, Ga. R. V. La Dow, superintendent of prisons.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m., September 14, for finishing and erecting machinery to operate the Stovey gate valves for controlling the main culverts and machinery to operate the cylindrical valves for controlling the lateral culverts of the Canal locks. As per Circular No. 596.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids August 9, for 1100 dozen hack-saw blades, 11,600 pounds steel bolts and nuts, 700 pounds composition bolts and nuts, 360 pounds scoop shovels (schedule 2714), 1600 pounds sheet brass, 4900 pounds rolled naval brass, 700 pounds sheet copper, 500 pounds spelter solder (schedule 2713).

New Incorporations

Ingalls-Shepard Forging Company, Harvey, Ill. Capital, $120,000. Incorporators, F. A. Ingalls, W. W. Weston, Wm. Lawson.

The Nathan M. Stone Company, Chicago, Ill. Manufacture metal. Capital, $15,000. Incorporators, M. M. Stone, J. J. Stone, E. E. Jackson.

Banner Automobile Company, St. Louis, Mo. Manufacture automobiles. Incorporators, Russell E. Gardner, Hugo Cartwright, Elmer L. Roninger.

J. A. Whitney Auto Sales Company, Cleveland, Ohio. Operate garage, etc. Capital, $10,000. Incorporators, J. R. Whitney, W. C. Sell, F. I. Burke, etc.

New Jersey Pie Company, Newark, N. J. Manufacture pies. Capital, $100,000. Incorporators, Wm. J. Cullen, Louis J. Elias, Wm. P. Martin.

Galva Heater Company, Galva, Ill. Manufacture heaters and boilers. Capital, $30,000. Incorporators, E. L. Yocum, C. M. Lyford, H. A. Smith.

Logan Brick Company, Logan, Ohio. Manufacture brick, tile, etc. Capital, $100,000. Incorporators, H. W. Fraser, B. T. Longenecker, G. C. Fryce, etc.

Whitney Richards Company, Cleveland, Ohio. Manufacture office fixtures. Capital, $10,000. Incorporators, C. N. Richards, M. S. Richards, H. A. Hauxhurst, etc.

Hub Wire Cloth and Wire Work Company, Boston, Mass. Manufacture wire. Capital, $15,000. Incorporators, Albert O. Littlefield, M. P. Littlefield, etc.

Newark Last Works, Newark, N. J. Manufacture shoe lasts. Capital, $100,000. Incorporators, John W. McGrain, E. D. Winchell, Israel Eisenstein.

Durant Pattern Company, Cleveland, Ohio. Manufacture wooden and metal patterns. Capital, $10,000. Incorporators, J. L. Flaherty, G. H. Durant, D. P. Simpson, etc.

Rich Tool Company, Chicago, Ill. Manufacture and deal in machinery and tools. Capital, $10,000. Incorporators, Alvin L. McElroy, L. F. Anderson, Frank W. Bigelow.

M. A. Hunt Company, Cincinnati, Ohio. Manufacture bed springs, bed steads, etc. Capital, $15,000. Incoporators, W. D. Hunt, W. O. Lathrop, Albert Bettinger, etc.

Rockford Milling Machine Company, Rockford, Ill. Manufacture and deal in machine tools, etc. Capital, $25,000. Incorporators, Edwin Adarcaf, Levin Faust, S. N. Anderson.

Hydro Vacuum Cleaner Company, Buffalo, N. Y. Manufacture vacuum cleaners. Capital, $100,000. Incorporators, Louis J. Bennett, L. J. Bennett, A. F. Krause.

National Railway Signal Company, Fostoria, Ohio. Manufacture railway signals, supplies, etc. Capital, $100 000. Incorporators, M. A. Lease, D. M. Urschal, J. Kechen, etc.

1 Roddey Automobile Company, Columbia, S. C. Manufacture automobiles, repair and garage business. Capital, $10,000. Incorporators, J. R. Roddey, J. J. Cain.

Broderick-Bolte Electrical Company, East St. Louis, Ill. Manufacture electrical appliances. Capital, $15,000. Incorporators, F. B. Bolte, C. F. Boderick, Chas. Chartrand.

Morgan, Hoover Company, Camden, N. J. Manufacture steel balls, machinery, castings. Capital, $100,000. Incorporators, John Morgan, Jr., L. J. Hoover, Oscar B. Bedrow.

Kewanee Foundry and Manufacturing Company, Kewanee, Ill. Manufacture tools and machinery. Capital, $40,000. Incorporators, Leo Brutus, Elmer W. Smith, T. H. Johnston.

Empire State General Vehicle Company, Rochester, N. Y. Manufacture vehicles, appliances, etc. Capital,$100,000. Incorporators, G. A. Hallister, R. M. Searle, J. T. Hutchings.

Herringshaw Company, East Liverpool, Ohio. Manufacture and sell hardware, plumbers' supplies, stores, etc. Capital, $15,000. Incorporators, C. N. Herringshaw, G. J. Wehrle, B. H. Schmul, etc.

International Metal Weather Strip Company, Jersey City, N. J. Manufacture metal-weather strips, etc. Capital, $100,000. Incorporators, L. H. Gunther, H. O. Coughlan, John R. Turner.

Dunkirk Electrical Manufacturing Company, Dunkirk, N. Y. Manufacture and deal in electrical fixtures, etc. Capital, $100,000. Incorporators, A. W. Cummings, H. T. Litchfield, O. B. Mulholland.

Ennisson Automatic Job-Press Manufacturing Company, Ridgefield Park, N. J. Manufacture printing presses, etc. Capital, $1,000,000. Incorporators, W. D. Stratton, W. Jay Ennisson, Edward E. Whittaker.

New England Sherardizing Company, Hartford, Conn. Sherardize, manufacture and deal in iron, steel, copper and brass. Capital, $80,000. Incorporators, Judson H. Root, J. F. Forward, I. K. Hamilton, Jr., etc.

Vandewater & Co., Ltd., Elizabeth, N. J. Manufacture internal combustion engines,

steam engines, automobiles, etc. Capital, $100,000. Incorporators, J. Correja, Islin, F. C. Vandewater, S. R. Vandewater, Elizabeth.

Hendry Laminated Leather Belting Company, New York. Manufacture belting, pulleys, etc. Capital, $10,000. Incorporators, Chas. H. Wilson, 65 Second avenue, Mt. Vernon, N. Y.; Alex. Hendry, 1414 Atlantic avenue, Brooklyn, etc.

Columbus, Mt. Vernon & Mansfield Traction Company, Columbus Ohio. Build and operate a traction line from Columbus to Mansfield and sell electric power. Incorporators, J. W. Lehman, J. M. Adams, David Lehman, etc. Capital, $10,000, to be increased to $2,000,000.

Trade Catalogs

The Hill Clutch Company, Cleveland, Ohio. Catalog. Friction clutches. Illustrated, 54 pages, 6x9 inches, paper.

Nappanee Iron Works, Nappanee, Ind. Catalog A. Portable cylinder boring bars. Illustrated, 16 pages, 6x9 inches, paper.

South Bend Machine Tool Company, South Bend, Ind. Catalog No. 40. Engine lathes. Illustrated, 32 pages, 6x9 inches, paper.

The Clark Automatic Telephone Switchboard Company, Providence, R. I. Catalog. Automatic switchboard system. Illustrated, 12 pages, 6x9 inches, paper.

Ingersoll-Rand Company, 11 Broadway, New York. Form No. 8003. "Imperial" Type "E" pneumatic hammers. Illustrated, 16 pages, 6x9 inches.

Hammacher, Schlemmer & Co., Fourth avenue and Thirteenth street, New York. Catalog No. 400. Hand screws and clamps. Illustrated, 30 pages, 5x7½ inches, paper.

Cincinnati Iron and Steel Company, Cincinnati, Ohio. Catalog. Cisco lathes, drills, clutches, bar benders, cranes, punches and shears, etc. Illustrated, 72 pages, 4x6½ inches, paper.

The United States Electrical Tool Company, Cincinnati, Ohio. Catalog G. Portable electrical hand or breast drills, radial drills, grinders, etc. Illustrated, 60 pages, 6x9 inches, paper.

Sprague Electric Company, 527-531 West Thirty-fourth street, New York. Bulletin No. 600. Single and polyphase induction motors. Illustrated, 40 pages, 8x10½ inches. Pamphlet No. 517. Flexible steel-armored hose. Illustrated, 12 pages, 3½x6 inches. Pamphlet No. 322-A. Electric fans. Illustrated, 20 pages, 3½x6 inches.

Forthcoming Meetings

Joint meeting of American Society of Mechanical Engineers and Institution of Mechanical Engineers, Birmingham, England, July 26-29, 1910.

Society of Automobile Engineers, convention of designers and superintendents, July 28, 29 and 30, Detroit, Mich. H. E. Coffin, president 1451 Broadway, New York City.

American Society of Mechanical Engineers; monthly meeting second Tuesday. Calvin W. Rice, secretary, 29 West Thirty-ninth street, New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's hotel. D. F. P. Clark, secretary, 309 Milk street, Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting fourth Tuesday each month. E. C. Bliss, president, 91 Sabine street, Providence, R. I.

New England Foundrymen's Association; regular meeting second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania; monthly meeting third Tuesday. Elmer K. Hiles, secretary, Fulton building, Pittsburg, Penn.

Superintendents' and Foremen's Club of Cleveland; monthly meeting third Saturday. Philip Frankel, secretary, 310 New England building, Cleveland, O.

Western Society of Engineers, Chicago, Ill. Regular meeting first Wednesday evening of each month, excepting July and August. Secretary, J. H. Warder, 1735 Monadnock block, Chicago, Ill.

WANTS

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendations or other papers of value should not be inclosed to unknown correspondents. Only bona-fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper catalog free. E. G. Smith, Columbia, Pa.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

If you want special machinery or tools designed, I can give you satisfactory service. Box 694, AMERICAN MACHINIST.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Patents. C. L. Parker, Patent Attorney, ex-examiner Patent Office, 920 G St., Washington, D. C. Write for Inventor's Handbook.

Wanted—Work for first class machine shop; light, fine special machinery, tools, jigs and experimental work. Boyce, 584 Hudson St., New York City.

Light, fine machinery and mechanical specialties built to order; jigs, tools, etc., designed and built. Goodson Electric and Manufacturing Co., Providence, R. I.

Wanted—Capital to promote the manufacture of automatic twist drill grinder, described in this issue. Other information address A. Mill, Jr., M. E., Cincinnati, Ohio.

A well equipped machine shop within 30 miles from New York solicits orders for all kinds of machine work. Send inquiries: The Brunswick Refrigerating Co., New Brunswick, N. J.

Light or medium weight machinery to manufacture on contract or special machinery to build. Box 734, AMERICAN MACHINIST.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Wanted—A concern consisting of foundry and machine shop, employing 150 to 200 men, would like to enlarge its business by manufacturing machines for other parties; estimates given. Box 662, AMER. MACHINIST.

Have you ever considered the advantages of publishing a book rather than a catalog to promote your sales; a book by a real author, made interesting so it will be read? It is not so costly. Write us. Cochrane Publishing Co., Tribune Bldg., New York.

A machine shop located near New York or Philadelphia, well equipped with modern tools and appliances, say from a 36-inch planer down, and wishing additional work, should write, giving general information regarding location and equipment. Address Box 729, AMERICAN MACHINIST.

Italy—Wanted: Agency of large American firm that wishes to begin or develop important business in Italy; good occasion Universal Exhibition Turin, 1911. (Office, 41 Union Square, 1014, New York). Bernouill & Cabibi, Turin. House founded 1878. First-class references in United States.

Wanted—Autogenous welding work; we weld (not braze) cracked or broken parts of cast iron, aluminum, brass, etc., by oxy-acetylene process; let us send you further information and references; you pay for successful repairs only; try us and be convinced. Waterbury Welding Works, Waterbury, Conn.

Machinists' and draftsmen's handbook; second edition, enlarged and revised; over 450 pages, including illustrations and tables for $2.50; from cover to cover it is full of valuable and helpful information; invaluable to the employer as well as the workman; don't send any money; simply send your order and receive the book on trust; look it over—if you like it, keep it; act today. Address Peder Lobben, Box 243, Holyoke, Mass.

Help Wanted

Classification indicates present address of advertiser, nothing else.

COLORADO

Due to the steady increase of our business, we are constantly in need of drill press, lathe, planer, grinder, Jones & Lamson and bench men; also toolmakers and tool smiths; good climate and location; steady work, good pay to first-class men; shop clean, light and well ventilated; 9 hours work. Address, stating experience. J. Geo. Leyner Engineering Works Co., Littleton, Colo.

CONNECTICUT

Wanted—A first-class mechanical draftsman on details and layouts; a good opportunity for a bright energetic man; must be quick and accurate; give age, reference, experience and rate expected. Address Box 1021, Bridgeport, Conn.

Wanted—Salesmen to handle on a generous commission basis, a well advertising and quick selling line of lathe tools; commissions given on all orders received from prescribed territory; send references with reply. Address "R. T.," AMERICAN MACHINIST.

Wood patternmakers, toolmakers wanted; first-class patternmakers on automobile work; also experienced toolmakers on automobile tools, jigs, fixtures and gages; highest wages paid. Apply, Factory Office, The Pope Manufacturing Company, Hartford, Conn.

INDIANA

Wanted—First-class automobile draftsman with some executive ability, capable of directing 12 or 15 men. Box 763, AM. MACH.

Wanted—Foreman to take charge of assembling and testing department in one of the most modern, uptodate automobile engine shops in the country; product is thoroughly established and the job will be steady for the right man; none but men who have had experience as foreman and who can furnish first-class references need apply. For full particulars address "Motor Assembler," Care AMERICAN MACHINIST.

IOWA

Shop Instructor Wanted—An intelligent man familiar with shop methods and himself a thorough machinist is wanted to take charge of shop instruction in the shops of the College of Applied Science, State University of Iowa, at Iowa City; the shops are new and new equipment is being purchased; salary $900 to begin with, payable in 10 installments for 9 months' work; advancement is assured to the right man. Address Wm. G. Raymond, Dean, Iowa City, Iowa.

MASSACHUSETTS

Wanted—Toolmakers, experienced on punch and die work. Apply Employment Department, General Electric Co., Pittsfield, Mass.

Man, experienced as foreman of gear cutting jobbing work; state age, experience and wages expected. Boston Gear Works, Norfolk Downs, Mass.

Wanted—A practical man with thorough knowledge of tool making to take the position of superintendent in a small growing manufacturing concern, one who has a knowledge of taps and dies and can produce results, also a knowledge of drafting and designing. Box 765, AMERICAN MACHINIST.

MICHIGAN

Machinists—Men experienced at assembling the mechanism of crane bridges. Box 183, Detroit, Mich.

Wanted—A few first-class toolmakers experienced on die, jig and fixture work for light manufacturing. Box 592, AM. MACH.

MINNESOTA

We want a foreman for machine shop in agricultural implement factory in Minnesota; must be uptodate and hustler as mechanic

and foreman; piece-work system; open shop; good pay and steady place to right man. Box 767, AMERICAN MACHINIST.

NEW JERSEY

Wanted—A-1 automatic operator on Cleveland machines; must be well recommended. Hartford Suspension Co., 156 Bay St., Jersey City, N. J.

Old established machine shop, manufacturing sheet metal working machinery, wishes to receive applications from men qualified for foremanship. Address "Foreman," Box 713, AMERICAN MACHINIST.

Draftsman Wanted—One accustomed to laying out and building machine tool jigs and fixtures; must be man of experience. Apply at the works of Henry R. Worthington, Harrison, N. J. Call for works manager.

NEW YORK

Wanted—Competent advertising man for large machinery manufacturer; state qualifications fully. Box 974, Buffalo, N. Y.

Wanted—First-class drop forgings die sinkers; shop surroundings particularly desirable. Box 755, AMERICAN MACHINIST.

Wanted—Two first-class boring mill hands; steady work and good pay to the right men. The Georgian Mfg. Co., Binghamton, N. Y.

Wanted—Experienced toolmakers, only competent parties need apply. Mergenthaler Linotype Co., 24 Ryerson St., Brooklyn, N. Y.

Wanted — Several first-class toolmakers; must be skilful, capable man; good wages, steady employment. Address Superintendent, Savage Arms Co., Utica, N. Y.

Wanted—First-class lathe, drill press and milling machine operators for both night and day work; state past experience, wage demanded and complete information in first letter. The Kirkham Motor Mfg. Co., Bath, N. Y.

Salesmen on a generous commission basis, competent, practical tool dressers or others capable of demonstrating the merits of the most successful steel hardening solution ever sold; five years' continuous use by responsible firms vouches for its value wherever water-hardening steels are in use. Box 760, AM. M.

Wanted—By large manufacturing concern in central New York, man familiar with steam and electrical power plants, millwright work, piping, etc., also general plant up-keep; must be a good executive and able to lay out and supervise work in master mechanic's department when required; give experience, age and salary expected. Box 737, AM. MA.

Wanted—We are constantly increasing our force and invite applications from the following: Machinists, lathe hands, screw machine hands, grinder hands, milling machine hands, motor assemblers, toolmakers, sheet metal die men; we run a nine-hour shop, have desirable surroundings, and offer steady position to desirable characters. Address Superintendent, Maxwell-Briscoe Motor Co., Tarrytown, N. Y.

Wanted—Instrument makers accustomed to precision work on surveying instruments and other high-grade apparatus; only those need apply who are confident of their ability to do such work; attractive and steady positions to industrious men of good habits. In applying state age, nationality, where employed the past three years, also salary received; give reference and salary expected; all correspondence will be held strictly confidential. Bausch & Lomb Optical Co., Rochester, N. Y.

OHIO

Wanted—A first-class die and toolmaker; steady work; good wages. Address P. O. Box 96, Piqua, Ohio.

Foundry foreman wanted for 200 men on engine and jobbing work; state age, experience and reference. Box 728, AMER. MACH.

Wanted—Several first-class draftsmen with experience on crane work; none others need apply; state age, experience and salary. Box 727, AMERICAN MACHINIST.

Wanted—Foreman to assume entire charge of brass finishing department in large manufacturing concern, making a complete line of standard brass valves. Box 671, AM. MACH.

First-class molder wanted to instruct apprentices and handy men on jobbing and engine work; open shop, no labor troubles of any description; state age, experience. Box 735, AMERICAN MACHINIST.

Wanted—Five A-1 metal specialty salesmen on large commission; no side line; only men familiar with earning from $150 to $250 per month need apply. Address the Buckley Specialty Co., St. Marys, Ohio.

Wanted—Chief draftsman to take charge of large engineering office; must have good technical and practical training, executive ability and capable of systematizing office and getting output; good opening with opportunity for advancement; state qualifications fully in writing. Box 753, AMER. MACH.

Wanted—A Cincinnati concern want a thoroughly competent and experienced mechanical designer with some knowledge of electrical work; no other need apply; permanent position and chance for advancement to right man; state experience and give references; salary at start $100 per month. Box 733, AMERICAN MACHINIST.

Wanted—First-class machinists, toolmakers die sinkers, lathe, planer, drill press, screw machine, boring and milling machine operators, wood patternmakers, brass molders, polishers, buffers, finishers, spinners, millwrights, hammermen and blacksmiths who are seeking positions or desirous of improving on those which they have, to register their names and addresses with the free Employment Department of the National Metal Trades Association. Address Commissioner's Office, 605 New England Bldg., Cleveland, O.

OREGON

Wanted—Competent machinists (strictly non-union) may secure steady work at wages from $3.50 up to $4.50 for 9-hour day; high grade work with modern tools in a comfortable, well lighted shop located in the finest country in the United States. Willamette Iron & Steel Works, Portland, Ore.

PENNSYLVANIA

Wanted—Lathe, boring mill and floor hands; good wages, steady work. The Blaisdell Machinery Company, Bradford, Penn.

Wanted—Machine shop foreman accustomed to machine tool manufacture on economical lines and designer of jigs for same; state age, experience and salary; correspondence confidential. Box 758, AMERICAN MACHINIST.

Wanted—Three toolmakers, good workers, experienced on small work similar to typewriter, etc.; steady work for good men; state age and experience; wages 35c. to 40c. per hour; factory 40 miles from Pittsburg. Box 766, AMERICAN MACHINIST.

Foreman—Press room foreman (in Philadelphia) to take charge of department having double and single-acting stamping and drawing presses; must especially be an economical producer and disciplinarian with undoubted ability in handling men; thorough knowledge of dies also important; dandy opportunity for a managing hustler; give age, experience and salary expected. Box 756, AMER. MACH.

The Monotype School is maintained to train young men to meet the constant demand for operators of our type casting and composing machine; these operators do so well that we receive more applications for places than can be filled; these qualifications carry most weight: Common sense, automatic machinery experience, printing office experience, type foundry experience. Full particulars will be furnished to inquirers who furnish the same information about themselves, and mention this paper. Lanston Monotype Machine Co., Philadelphia.

WASHINGTON

Wanted—By large engineering works in Seattle, Wash., engaged in marine and land work, first-class engineering draftsman who has had experience in designing machinery and boilers; none but first rate men need apply; references required. P. O. Box 1905, Seattle, Wash.

WISCONSIN

Wanted—General foreman for well equipped shop, making small machines; good executive; experienced in economical production. Milwaukee. Box 754, AMERICAN MACHINIST.

Wanted—Shop manager; desire to have man with executive ability, capable of systematizing, increasing and cheapening production in young concern, building heavy machinery. Box 750, AMERICAN MACHINIST.

Shop man who understands the rapid and accurate production of small, interchangeable parts, and who has a good knowledge of production of stampings; must be sober, energetic and good mechanic; state age, experience, salary expected, where employed at present, and reasons for desiring a change. "X. Y. Z." AMERICAN MACHINIST.

FOREIGN

Werkzeugmaschinen- & Werkzeugfirma in Wien sucht zu möglichst sofortigem Eintritt einen Reisenden für die Balkanstaaten, welcher in erstklassigen Werkzeugmaschinen & Werkzeugen amerik. Provenienz gute Branchekenntnisse und Erfolge aufzuweisen hat; Ausführliche Offerte mit Zeugnisabschriften, Angaben über Militär- & Familienverhältnisse, Sprachkenntnisse, Religion, Alter, Gehaltsansprüche, ect. und Bild erbeten an. Box 736, AMERICAN MACHINIST.

SITUATIONS WANTED

Classification indicates present address of advertiser, nothing else.

ILLINOIS

Experienced, practical, systematic, superintendent in charge of a large manufacturing plant, wishes to make a change. Box 686, AMERICAN MACHINIST.

MASSACHUSETTS

Wanted—By a practical mechanic with executive ability, well up in modern machine shop and tool room practice, with twenty-two years' experience, a position as foreman, now holding similar position good reference location immaterial. Box 757, AMER. MACH.

NEW HAMPSHIRE

Wanted—Position as manager or superintendent of manufacturing concern; young man with exceptional experience. Box 759, AMERICAN MACHINIST.

NEW YORK

Chief draftsman wishes to make change; general mill work, rolling mill, furnaces, etc. Box 764, AMERICAN MACHINIST.

Man of experience in pump manufacturing and similar work, desires position as superintendent; A-1 references. Box 739, AM. M.

General foreman, middle age, now employed, latest methods, engineering, electrical and general machinery; A-1 hustler; can handle force with executive ability. Box 762, AMERICAN MACHINIST.

OHIO

A young mechanical engineer of ability, desires position as salesman, inspector or engineer of construction; a location west of Mississippi river preferred. Box 761, AM. M.

PENNSYLVANIA

Middle aged American, 25 years' toolmaking, machine shop, automobile, erecting, electrical and tool-steel salesman, experience, desires responsible position. J. E. P., Colonial Hotel, Pittsburg, Pa.

Expert mechanical engineer with wide experience, accustomed to large works, thoroughly versed in designing, organization, purchase and layout of tools, increasing production in machine shop, foundries and manufacturing plants, desires position. Box 745, AM. M.

Position wanted as superintendent or foreman with a reliable firm in the manufacturing of plumbing supplies, general brass and iron goods; have 18 years' experience; familiar with uptodate tools and machines; a hustler; sober and steady practical mechanic; A-1 references; city or country. Box 723, AMERICAN MACHINIST.

Foundry and machine shop superintendent, experienced in both branches, also in general office practice, systematizing, etc.; qualified to take entire charge of plant as works manager or superintendent; eighteen years' experience on pumps, valves and general machinery; good reasons for changing and excellent references. Box 752, AMER. MACH.

UTAH

Toolmaker, energetic man, extensive experience, die tool work, interchangeable manufacturing, seeking position; age 30. Care of Berger, 337 East 7th South St., Salt Lake City, Utah.

FOR SALE

For Sale—Full working drawings of a three cylinder 5½"x7½", four cycle, latest improved marine engine, complete with direct driven water and oil pumps and air compressor; money maker for machine shop wanting high class engine to build. Beck & Sargent, Engineers, 152 Lake St., Chicago, Ill.

We have a foundry and machine shop worth over $20,000; will sell for one-third of its value to any one who can furnish capital and run same in south, five miles from deep water way, near city of 100,000 population; a snap for some one. Write for further information if interested. Box 751, AM. MA.

For Sale—Three return tubular boilers, manufactured by Riter Bros., Buffalo, N. Y. Drums 72x16 feet 0 inches; each boiler with sixty-six 4-inch tubes; inspected by Travelers Indemnity Company, of Hartford, Conn; 93 lb. steam pressure; boilers in good condition; can be delivered in two to three months, and seen in operation at Buffalo Bolt Company's plant, North Tonawanda, N. Y.

For Sale—One Nash gas engine, 20 horsepower, two cylinder, for electric lighting, pumping or power; one Beaman & Smith horizontal boring mill; table 25 inches wide, 36 inches long; will bore 12 inches diameter, 24 inches long, and face 20 inches diameter; one 300 light J. B. Colt Co. acetylene gas apparatus. The above machines are in excellent condition, having been very little used. For further particulars and prices apply to Rider Ericsson Engine Co., 35 Warren St., New York

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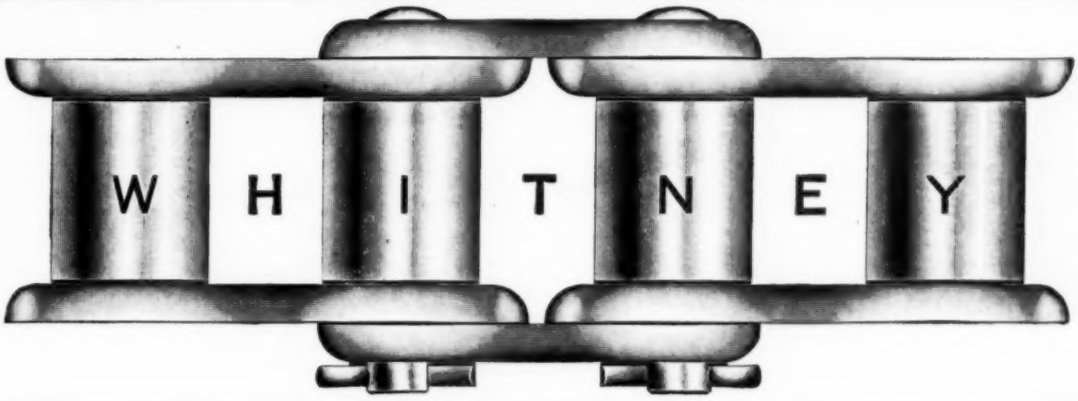
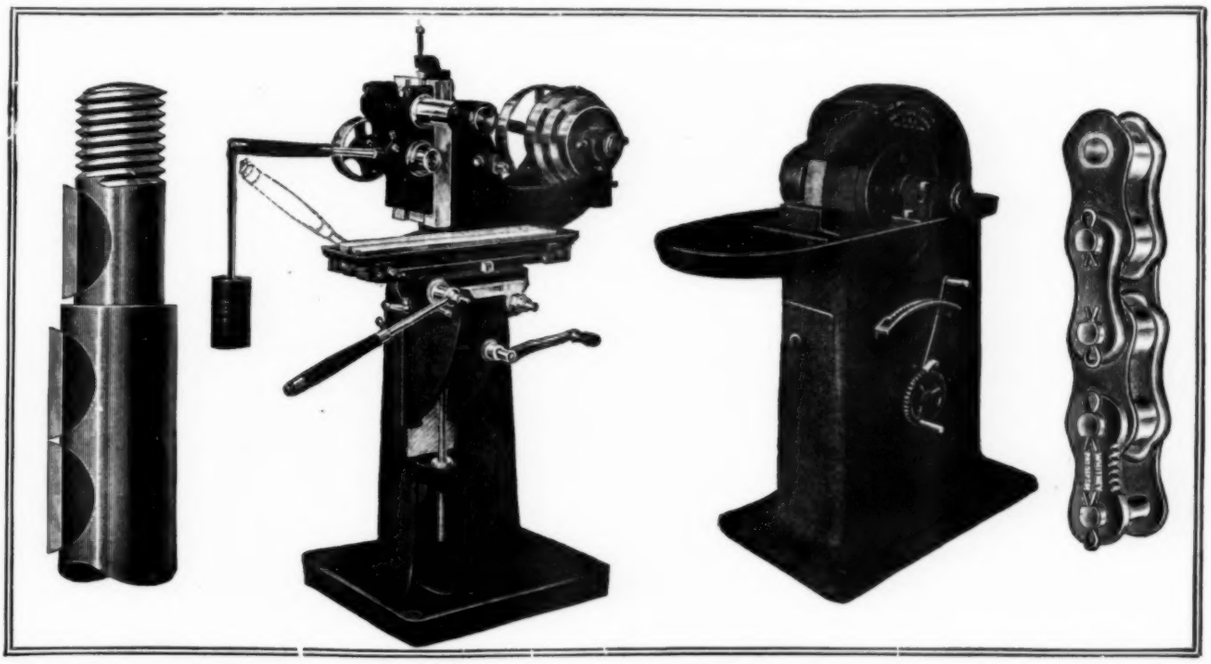


Chain Department

Roller Chains, Block Chains, Chain Belts, Quiet Chains, for Automobiles, Commercial Cars, Motorcycles, Bicycles, Machinery, etc.

Machine Department

Hand (feed) Milling Machines, 20-inch Water Tool Grinders, Keys and Cutters for the Woodruff Patent System of Keying, Presto Drill Chucks, Collets and Friction Tapping Devices.



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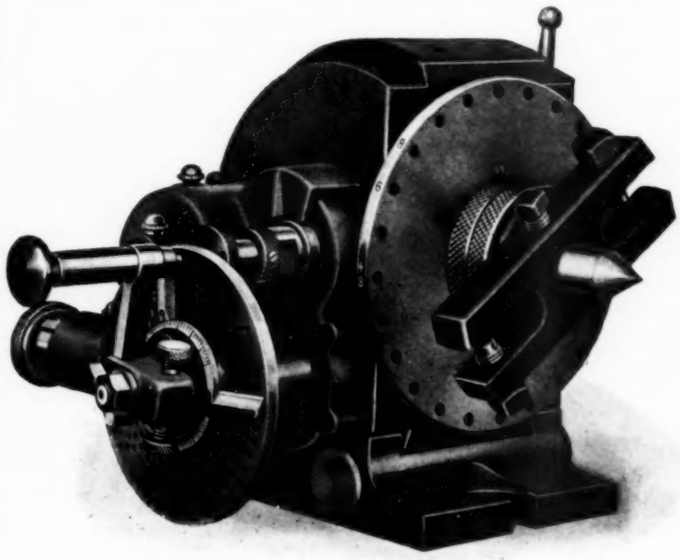
The Worm is Hardened and Ground,— An Exclusive B. & S. Feature



The Spiral Head of a B. & S. Universal Milling Machine

UNLESS a spiral head is extremely accurate its very purpose is defeated. Accordingly great care must be exercised in the design and workmanship, especially in the cutting of the worm and worm wheel. Any wheel that shows an accumulated error of .001″ does not pass inspection.

But inaccuracy is likely to creep in through wear and bruises caused by the throwing of the worm and wheel in and out of mesh for different varieties of work. The possibility of this danger is eliminated in the worm by its being hardened. It is then ground afterwards to remove any inaccuracy that might have resulted from the hardening.

Other B. & S. Spiral Head Features are the graduated Index Sector which simplifies the adjustment of the sector arms, and the adjustable index crank making possible delicate adjustments of the crank.

Write us for further particulars.

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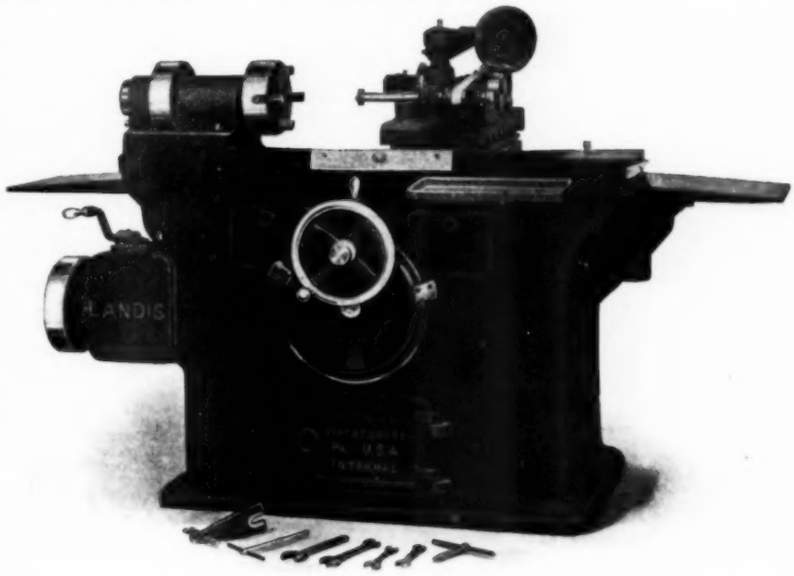

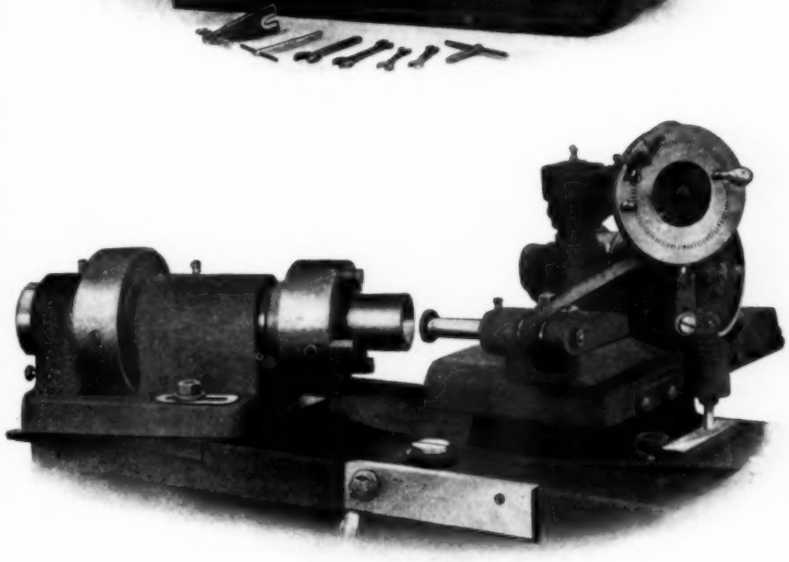

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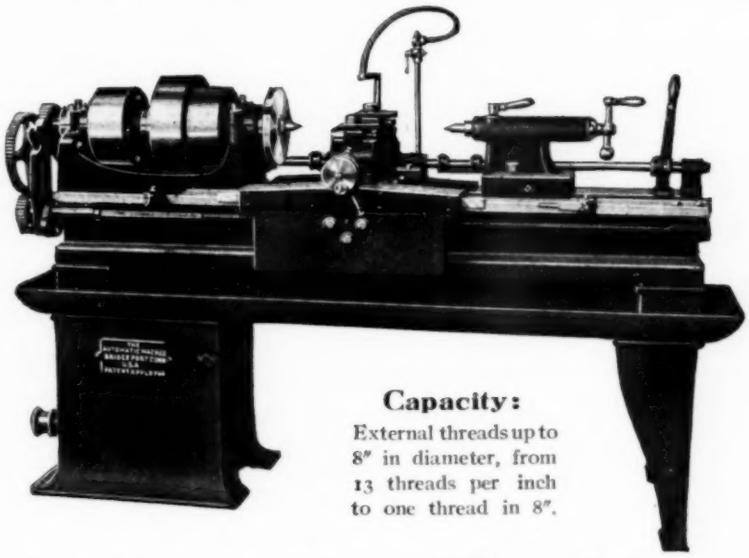

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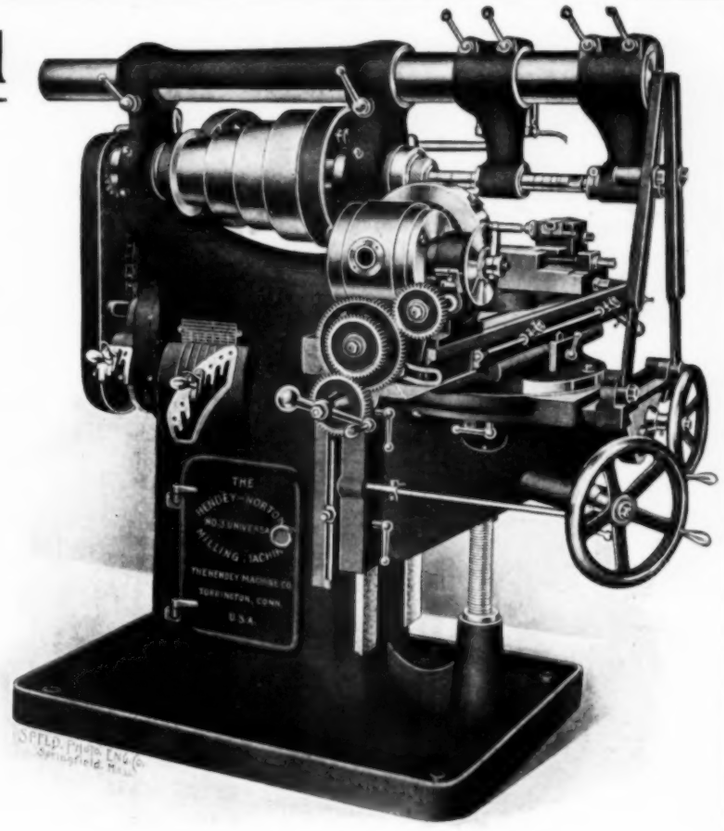

FEEDS 30x10x19″ all automatic, with positive roller chain drive. Working surface of table, 48¾″x11″. Main spindle has taper journals running in annular bearings fitted with ring oilers. Knee rigidly braced and has projected bearing on column of machine. Elevating screws telescopic. Table feed screw fitted with ball bearing thrust. Dividing head spindle travels through an arc of 216 degrees. Head has tool steel worm running in oil bath. Is tested for accuracy in divisions on an 8″ diameter plate. All feeds and reverse of same within easy control from front of knee.

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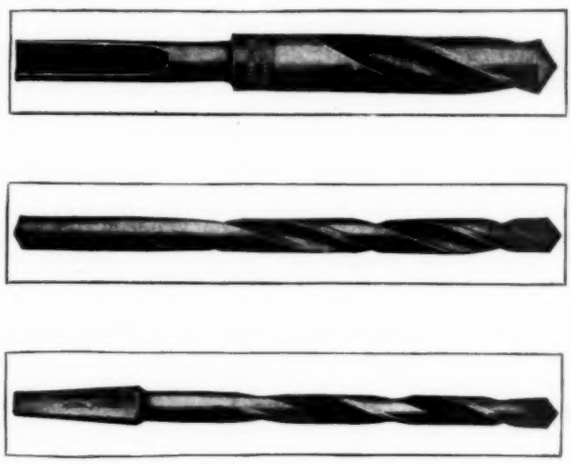

THE worth of a drill depends on what it will perform and also how well it will perform it.

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That is the *standard* which we have set for our drills and from the reports received they are up to the standard.

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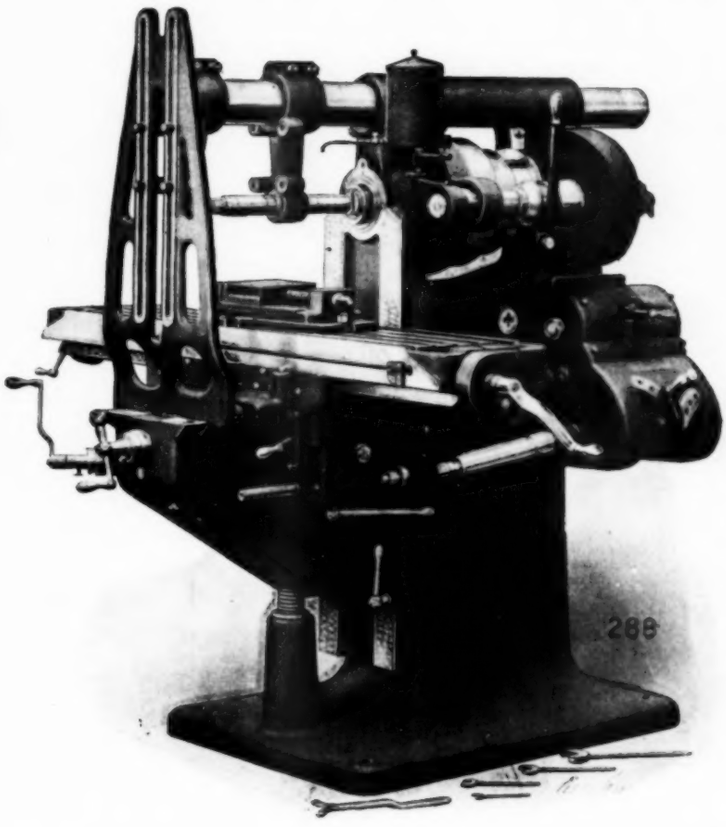

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The **driving power** of this miller is greater than any other cone type miller built.

The **double friction back gear** is to the milling machine what the **friction head** is to the chucking lathe.

The feed is **spur gear** driven **throughout, eliminating** the great **frictional losses** found in other miller **feed mechanisms.**

The design is so **rigid** that these features can be used to advantage on **any class of work.**

The spindle bearing is **hardened** and **ground** and runs in a **cast iron** box, thus insuring **permanency** of alignment.

These are a few reasons why Le Blond Millers **lead** in production capacity.

The R. K. LeBlond Machine Tool Company
Cincinnati, Ohio

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